BROOKLYN BOTANIC GARDEN

# PLANTS & GARDENS

BROOKLYN BOTANIC GARDEN RECORD

# PLANTS & GARDENS

## HANDBOOK ON GARDEN PESTS

How to Control
Plant Diseases
and Pests
with
Sprays and Dusts,
Systemics,
Cultural
Practices

* * *

PEST CONTROL
CHART
for 120
Garden Plants

SPRING
1966
NEW SERIES
*Vol. 22 No. 1*

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# PLANTS & GARDENS

Vol. 22 Spring (May) 1966 No. 1

## HANDBOOK ON GARDEN PESTS

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Published quarterly at 3110 Elm Avenue, Baltimore, Md., by the **Brooklyn Botanic Garden, Brooklyn, N. Y. 11225.** Second-class postage paid at Baltimore, Md., and at additional mailing offices. Subscription included in Botanic Garden membership dues. To others, $3.00 per year ($5.00 for two years). Copyright, 1966, by the Brooklyn Botanic Garden.

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*Courtesy Edward H. Scanlon and Associates*

*PARENT OF RESISTANT ELMS.* The European field elm (*Ulmus carpinifolia*) has given rise to the 'Buisman' elm, which is moderately resistant to Dutch elm disease. This species is also in the ancestry of the 'Groeneveld' elm (see pages 89 and 100). Nursery stock of 'Buisman' was first distributed in the United States in 1946. The resultant trees are expected to assume more or less the shape of this plant.

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Spring 1966

The "rule of the jungle" applies to both the plant and animal worlds—but there are sharp differences. The very concept provokes solemn thoughts.

We know that smaller animals are the prey of larger ones, and that little fish are eaten by bigger fish. But what about the disease-producing plants that prey on other plants, i.e., that live as parasites on others?

These are the little ones, often microscopic in size, and it is the bigger plants they feed upon. They lack the ability to manufacture their own food, so to gain a livelihood they must somehow penetrate the tissues of green plants—or get in through wounds. Once in living cells of the plants that serve as hosts, they absorb the sugars and other nutritious materials needed for their growth and reproduction.

This is, of course, an over-simplification, but in essence it gives an idea of the "rule of the jungle" in the plant world—wherein very little plants prey on big ones. It is also the essence of the problem of plant disease, because invaders not only rob larger plants of food, but they also secrete toxic substances—which in turn either kill, partially kill, or cause disease symptoms in the host plants.

Plants-feeding-on-plants is only a part of the story of this Handbook. Insects can be equally pestiferous, the little ones feeding on plants much larger than they are. Some are sucking insects living on plant juices; others actually eat plant tissues—like animals grazing in a pasture. It is particularly disturbing when ornamental garden plants (shrubs, trees, annuals or perennials) constitute the insect pastures.

Whatever the means of controlling a plant pest, whether insect or disease, the real trick is to destroy it without damaging the generous host on which it lives. This Handbook tells how this can be done. While there may not be light reading between its covers, there is expert guidance for almost every pest problem that confronts the grower of ornamental plants—whether in house, window box or garden.

Drs. Westcott and Walker and the seven other experts they invited to collaborate with them have performed a great service in preparing this Handbook for laymen and experts alike. All of us here at the Botanic Garden hope it will prove to be a highly useful and down-to-earth item on your reference shelf.

Lest "organic-garden-minded" readers gain the impression that the Botanic Garden overemphasizes chemical sprays, let it be said here that our cultural practices include all the sound "organic" methods known. But when sprays are immediately needed to maintain the health and good appearance of trees, shrubs or other garden plants, we use them.

George S. Avery, Jr.

Director

CORRECTION: We are embarrassed to have our attention called to the fact that the photograph on the cover of the Winter 1965-66 issue of PLANTS & GARDENS is not *Sequoia sempervirens* but *Sequoiadendron giganteum* (*Sequoia gigantea*).

# ARE PLANT SPRAYS NECESSARY?

## Cynthia Westcott

IN 1962 Rachel Carson's *Silent Spring* exploded in our midst. It dramatized the dangers of pesticides and focused attention on alternative methods of control. In describing such methods Miss Carson drew heavily on the Brooklyn Botanic Garden's Handbook on *Biological Control of Plant Pests,* published in 1960. The Handbook is still available and should be consulted for a thorough groundwork in this expanding field. Increased appropriations for research in biological control are partly due to the publicity given by *Silent Spring.* Work is continuing, principally in these directions:

1. *Parasites and predators.* Most pest insects are under some natural control by other insects. When a new pest arrives in this country without its natural enemies we send experts abroad to search for these. In 1888 *Vedalia,* an Australian lady beetle, was introduced into California and was spectacularly successful in controlling cottony-cushion scale on citrus. Since then there have been about 100 instances giving some control of imported pests, many more trials with no success. Certainly gardeners should make every effort to encourage beneficial insects by restricting spraying to plants likely to be seriously damaged by harmful insects. Wherever possible avoid broad-spectrum insecticides, those that kill many insects, not just the target pest.

2. *Microbial diseases.* Bacteria and viruses are becoming potent weapons against insect pests, and sometimes fungi, too, can inflict diseases on pests of garden plants. Spores of the bacteria causing milky disease have long been used to kill Japanese beetle grubs and recently a way has been found to develop these spores in laboratory culture. Commercial preparations of *Bacillus thuringiensis,* applied as any chemical spray, are being used in the fight against gypsy moths and other caterpillars. Macerated bodies of sawfly larvae infected with a polyhedrosis virus, disseminated by airplane, give excellent control of pine sawflies.

3. *Interference with reproduction.* A very promising development has been the sterilization and release of male insects. When these males mate with females the eggs are infertile. Sterilization has been achieved by irradiation and also by chemical means. The latter sterilants are poisons, just as chemical sprays, and must be used with care. Hormones are now being tried to prevent the metamorphosis of an insect from the larval to the adult reproductive state.

4. *Sex attractants.* Instead of wide-scale spraying it is possible with some insects to use a synthetic attractant, duplicating the chemical emitted by the female insect to attract the male. Killing is then accomplished with a small amount of poison at the bait station. We already have such lures for the gypsy moth (Gyplure) and for the Mediterranean fruit fly (Medlure).

5. *Resistance.* We are constantly striving for plants resistant to attack by insects or diseases and we are sometimes successful. But it is a continuing struggle because the pest usually produces another race or strain to which the host becomes susceptible.

6. *Companionate planting.* Some gardeners believe that garlic and other odoriferous plants, placed in or around beds of ornamentals, will ward off pests but there have been few scientifically controlled tests. We do have some evidence that root exudates from marigolds, and also asparagus, may inhibit certain nematodes.

## The Common Sense Approach

Most research must be left to the experts but a gardener can do many things, besides spraying, to keep his own pests at a minimum. First is *exclusion.* Never try to smuggle in a plant, bulb or seed from a foreign country. The tiniest bit of soil on roots or blemish on seed or plant may harbor some stage of a pest. Get the proper permits and acquire your imports legally.

Do not move live material from state to state without a certificate of inspection. Be very cautious about accepting gift plants from a neighbor. They may bring problems you do not yet have.

Plan your garden to avoid future trouble. Diversify the plantings; don't have large blocks of the same species. Keeping plants away from too many of their own kind prevents infection through natural root grafts, reduces infection from air-borne pathogens. Native plant material may be hardier than similar introduced plants but it is also the first to succumb if a foreign pest manages to get in. Keep a balance between natives and exotics.

Avoid alternate hosts. Don't plant redcedars near crab apples nor Douglas-fir near blue spruce. Avoid a build-up of pests from one plant to another. Primroses are very susceptible to spider mites. Planted around a rose bed they make it more difficult to control the mites on roses. Avoid planting edibles, such as mint or strawberries, near a rose bed that may be sprayed weekly with poisons.

Various sanitary measures are important in pest control, including the removal of weeds, cutting out of plant tissue infected with disease or infested with animal pests. Pruning cuts should be made flush with the trunk or just above a bud, leaf or branch, leaving no stub. It is usually safer to work among plants when they are dry.

## If Spraying is Indicated

If we conscientiously follow all alternative control measures is spraying still necessary? Emphatically, yes! Without chemicals it would be impossible to provide food, shelter, clothing, and landscape beauty for our increasing population. The dangers of chemicals in food have been greatly exaggerated. In April, 1965, the U.S. Food and Drug Administration reported that pesticide residues in the U.S. food supply are insignificant from a health standpoint. In January, 1966, the same administration reported on total diet samples, figuring the amount of pesticide residue that might be consumed over a period of two weeks by a male 18 or 19 years old. Samples of many foods from 18 markets in three geographical areas were analyzed for 50 chemicals. Modern methods allow for detection of very minute quantities. The amounts found in food prepared for consumption were very small, substantially less than the legal tolerances that have been established.

There have been a few accidents with pesticides, mostly to children and due to adult carelessness, and there have been some careless operators. Some modern chemicals are more dangerous to handle than older pesticides and some are much safer. DDT is relatively safe for mammals but it does have a long residual effect, may interfere with reproduction in birds, and is very toxic to fish, building up in the food chain. It is still the most effective weapon against some pests and the overall benefit must be weighed against possible harm. In home gardens, in small amounts applied only as necessary for specific pests, it may be still recommended.

We present on the following pages a chart to simplify pest control either by the home-owner or his arborist. Some of the more common pests are listed under the plants they attack, and a choice of pesticides is provided. Some are safer to handle than others. Please refer to Dr. Pyenson's article, page 37, for degrees of hazard associated with the various chemicals. No one garden supply center will have all the materials listed but the local store should have something that will suffice for the enumerated pests.

(*Concluded at bottom of next page*)

# FAMILIAR PLANTS — THEIR COMMON PESTS AND DISEASES AND HOW TO CONTROL THEM

*All photographs by author, except where otherwise noted*

| Pests of specific plants | Means of identification | Control measures |
|---|---|---|
| **African-violet** (*Saintpaulia*) | | |
| Cyclamen Mite | Plants stunted, deformed, stems twisted, buds black | Spray with Kelthane or Thiodan |
| Mealybug | Small white oval insects covered with wax | Malathion dip or spray |
| Nematodes, leaf and root | Plants unthrifty; knots on roots | Destroy sick plants; pot in clean soil |
| Powdery mildew | White powdery spots on leaves | Karathane or Acti-dione PM |
| Ring spot | Pale rings from water colder than leaf | Use water at room temperature |
| Petiole rot | Stem rots where it touches rim of pot | Use plastic pot or cover rim with foil |
| **Ageratum** (*Ageratum*) | | |
| Whitefly | Leaves stippled white, tiny "moths" on underside | Spray with malathion, rotenone or lindane |
| **Ailanthus** (*Ailanthus*) | | |
| Cynthia moth | Large green caterpillars may defoliate trees | Spray with Sevin, malathion or lead arsenate |
| Ailanthus webworm | Olive-brown, white-striped caterpillars feed in webs | Control seldom necessary |
| Verticillium wilt | Leaves turn yellow; branch or entire tree dies | No real control; do not replant with ailanthus or maple |
| **Amaryllis** (*Hippeastrum*) | | |
| Narcissus bulb fly | Large yellow maggot in decaying bulb | *See* NARCISSUS |
| Bulb mite | *See* HYACINTH | Discard soft bulbs |
| Convict caterpillar | Bark larvae with cream bands devour leaves | Dust with DDT |
| Leaf scorch (red blotch) | Reddish spots on flowers, leaves, bulb scales; stalks deformed | Avoid heavy watering; spray with zineb or ferbam |

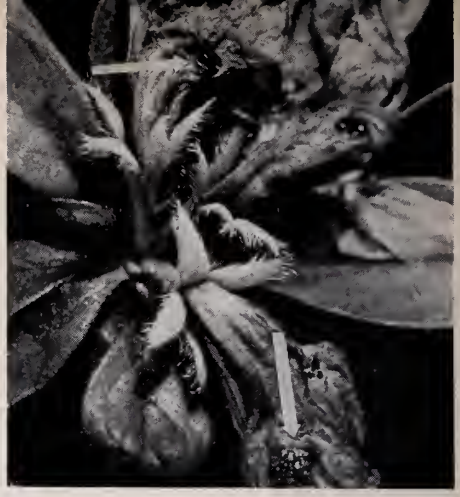
(*Continued from page* 5)

No gardener should expect to be able to control all his plant diseases and insect pests. He will spray his hobby plants and background shrubs and leave the rest to natural control. And by not drenching everything in the garden natural control will have a better chance. In some cases, as with roses, an all-purpose spray is the best solution, but where only one pest is a problem at a particular time it is wiser to use a specific material directed just to that pest.

The dates given in the chart are for the New York City area but the plants included also represent other sections of the United States.

More elaborate descriptions of many pests are given in succeeding articles. Consult the Index for their location. Illustrations are indicated in boldface type.

| | | |
|---|---|---|
| **Andromeda** (*Pieris*) | | |
| Andromeda lace bug | Foliage stippled white or gray; insect broods April to October | Lindane, malathion or Sevin when bugs hatch |
| Spider mite | Yellowing leaves; sickly bushes | Aramite, Kelthane or Cygon |
| **Anemone, Japanese** (*Anemone japonica*) | | |
| Black blister beetle | Long slim black beetle on flowers, foliage | Sevin or DDT |
| **Arborvitae** (*Thuja*) | | |
| Bagworm | Spindle-shaped bags hanging on twigs; caterpillars may defoliate | Cut out in winter; spray in June with Sevin, malathion, chlordane or Cygon |
| Spider mite | Foliage dusty with fine webs; trees yellow or brown | Aramite, Kelthane or Tedion |
| Arborvitae weevil | Grubs eat roots; adults eat cup-shaped areas from new needles | Spray with DDT or lindane, or treat soil with chlordane |
| Arborvitae leaf miner | Needles or twigs turn white or brown | DDT plus a miticide |
| Black vine weevil | *See* YEW | |
| Arborvitae aphid | Reddish-brown insect with white bloom, on roots, stems | Lindane or malathion |
| Arborvitae soft scale | Large brown hemispherical shells on twigs | Malathion or summer oil |
| Juniper scale | Small round whitish scales | *See* JUNIPER |
| Leaf shedding | Inner leaves turn brown, drop in autumn | Natural fall; no control |
| **Aspidistra** (*Aspidistra*) | | |
| Fern and other scales | Brown, oyster-shaped females, thin white males | Malathion when young are crawling |
| **Aster, China** (*Callistephus chinensis*) | | |
| Root aphids | Plants yellow, wilting; powdery lice at roots | Pour lindane around base of plant |
| Leafhopper | Small greenish insects suck sap, transmit yellows | DDT, Cygon, malathion or Sevin |
| Tarnished plant bug | Black shoots; small, mottled brown bug | DDT or malathion |
| Blister beetle | Black, striped or margined beetle on flowers | Sevin, DDT or lindane |
| Aster yellows (virus) | Stunted, chlorotic plants with greenish flowers | Control leafhopper vectors or grow under cloth |
| Aster wilt | Plants wilt, die, from soil fungus that invades vessels via roots | Select resistant varieties; grow in new location |
| **Aster, Perennial** (*Aster*) | | |
| Aster aphid | Greenish lice common on New England aster | Spray with malathion, lindane or nicotine |
| Powdery mildew | Common in late summer | Acti-dione PM or Karathane |
| **Azalea** (*Rhododendron*) | | |
| Azalea lace bug | Leaves stippled, rusty flecks on underside | Lindane, malathion or Sevin |



Azalea petal blight. *Left*: Preliminary spotting of flowers, which grow slimy and eventually collapse. *Right*: Resting bodies (sclerotia, shown at arrows), which perpetuate the disease.

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|---|---|---|
| **Azalea** (*continued*) | | |
| Azalea bark scale | White cottony fluffs on stem | Malathion or Cygon |
| Spider mite | Leaves turn yellow and drop | Aramite, Kelthane, Tedion or Cygon |
| Azalea whitefly | Greenish ovals on underside of leaves of white, hairy varieties | Malathion or Cygon |
| Azalea leaf miner | Small caterpillars roll leaves | Lindane, malathion or diazinon |
| Azalea stem borer | Yellow caterpillar in twigs | Cut out |
| Azalea petal blight | Flowers wilt to slimy mush; black sclerotia on petals | Spray 2 or 3 times a week with zineb |
| Leaf gall | Bladderlike enlargement of leaf or flower bud | Remove; use ferbam or zineb before leaves unfold |
| Leaf scorch | Tan dead areas in leaves | Ferbam at bud break and 10 and 20 days later |
| Bud and twig blight | Tan buds, covered with black "pins" | Prune infected branches |
| Powdery mildew | Lilac mildew on deciduous azaleas | *See* LILAC |
| **Barberry** (*Berberis*) | | |
| Barberry aphid | Small yellow lice clustered on shoots | Lindane, malathion or nicotine |
| Barberry scale | Reddish convex scale on twigs | Dormant oil or malathion for crawlers |
| Japanese weevil | Crescent notches in foliage | Spray with DDT |
| Barberry webworm | Leaves, twigs, webbed by black, white-spotted caterpillars | Lead arsenate, DDT, or Sevin |
| **Beech** (*Fagus*) | | |
| Woolly aphid | White wefts on underside of leaves; cottony lice on bark | Malathion or lindane in late spring |
| Cankerworm | Inchworm caterpillars | Sevin or DDT after leaves expand |
| Saddled prominent | Caterpillar, 1½ in. long with green or purple markings, may defoliate | As above |
| Beech canker | Bark disease following beech scale | Control scale with malathion |
| Leaf scorch | Burning from hot sun after cloudy weather | No control |

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| **Begonia** (*Begonia*) | | |
| Melon aphid | Small lice, usually dark green | Malathion or lindane |
| Mealybug | Oval, white, cottony insects at leaf axils | Malathion spray or dip |
| Greenhouse thrips | Leaves deformed, silvery, with dark specks of excrement | Malathion or lindane |
| Black vine weevil | Grubs eat roots of tuberous begonias | Treat soil with chlordane or dieldrin |
| Leaf nematode | Water-soaked blotches in leaves; plants stunted | Use care in watering |
| Botrytis blight | Dark areas with gray mold on leaves, flowers | Avoid wetting foliage; keep plants spaced; captan or zineb |
| **Birch** (*Betula*) | | |
| Birch leaf miner | Large brown leaf blotches; trees appear blighted | Lindane, Cygon, Sevin or malathion when leaves half out, fully out, and 6 weeks later |
| Bronze birch borer | Trees die back from top; grubs mine under bark | DDT or dieldrin in late May; repeat in 3 weeks |
| Cankerworm | Green or dark inchworms chew holes in leaves | Sevin, DDT or lead arsenate as leaves expand |
| Birch aphid | Dense colonies of green lice, often followed by sooty mold | Lindane, malathion or Cygon |
| Canker | Irregular swellings and callus formation | Cut out where possible; feed and water trees |
| **Bittersweet** (*Celastrus*) | | |
| Euonymus scale | *See* EUONYMUS | |
| Bean, ivy aphids | Black lice on new growth | Lindane or malathion |
| **Boston-ivy** (*Parthenocissus*) | | |
| Japanese beetle | Leaves chewed to lace | DDT or lead arsenate; do not use Sevin on this host |
| Virginia-creeper leafhopper | Foliage whitened | *See* VIRGINIA-CREEPER |
| Leaf spot | Irregular brown spots, especially on new leaves, in wet seasons | Spray with ferbam or copper, starting when leaves expand |
| **Box-elder** (*Acer*) | | |
| Box-elder bug | Red-and-black bugs on flowers, leaves, fruit; enters houses | Lindane or chlordane on trees, house walls; remove pistillate trees |
| **Boxwood** (*Buxus*) | | |
| Boxwood leaf miner | Yellow maggots in leaf blisters; orange flies emerge in May | DDT in early May, or malathion or Cygon in July |
| Boxwood mite | Foliage gray or yellow with minute "scratches" | Aramite, Kelthane, Tedion or Cygon |
| Boxwood psyllid | Terminal leaves cupped around cottony white nymphs | DDT, lindane or malathion, April, May |
| Oystershell and other scales | Dark, oyster-shaped scales on stems | Dormant oil or dinitro, or malathion for crawlers |
| Meadow nematodes | Bushes stunted, leaves bronzed, roots sloughed off | Treat soil with Nemagon or V-C 13 in spring |
| Canker (blight) | Branches dying, tips straw-colored; salmon spore pustules on leaves, stems | Clean out bushes; spray with phenyl mercury or 1-50 lime sulfur |
| Wind burn and sunscald | Tops bleached in early spring sun and wind | Spray with Wilt-pruf or use a windbreak |

Camellia flower blight. *Left:* In its early stages. *Right:* The mushroom-like bodies (apothecia) of the fungus that causes this disease, shown about natural size.

| | | |
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| **Bugleweed** (*Ajuga*) | | |
| Crown rot | Plants wilt, turn black; reddish tan sclerotia on white fungus threads | Remove plants and surrounding soil; treat area with Terrachlor |
| **CACTI** | | |
| Mealybug | White fuzzy insects at base of spines; cause yellowing | Remove with toothpick swab dipped in alcohol or spray with malathion |
| Spider mite | Plants gray, yellow or white with fine webs | Syringe off with water or spray with Kelthane |
| Cactus and other scales | Gray, circular females, thin white males | Scrub off with brush. Malathion on tolerant varieties |
| **Calendula** (*Calendula*) | | |
| Aphids | Black or green lice common on buds, flowers | Malathion, lindane, nicotine or rotenone |
| Cabbage looper | Green caterpillar with white stripes | Malathion or Sevin |
| Blister beetles | On flowers, foliage | *See* ASTER |
| Aster yellows | *See* ASTER | |
| **Camellia** (*Camellia*) | | |
| Tea and other scale | White filaments with dark shells on underside of leaf; upper surface mottled yellow | Cygon or white-oil spray after flowering |
| Fuller rose beetle | Notches eaten from leaves at night by gray-brown weevil | Dust stems with chlordane or lindane |
| Camellia flower blight | Flowers turn brown, drop, with hard, black sclerotium in center, from which spore-bearing apothecia are produced next spring | Treat soil with Terrachlor just before blooming; clean up fallen flowers; buy plants bare-rooted, all buds showing color removed |
| Dieback (various causes) | Twigs die back; leaves turn brown; cankers on old wood | Cut out diseased portions; spray with copper |

| | | |
|---|---|---|
| Leaf gall | Leaves greatly swollen | Pick off and burn |
| Leaf spot | Silvery or brown spots due to sun or wind | Grow under pines or other light shade |
| **Canna** (*Canna*) | | |
| Japanese beetle | Very fond of flowers, leaves | Sevin or DDT |
| Larger and lesser canna leaf rollers | Large green and small yellow caterpillars roll, tie leaves | Spray or dust early with DDT |
| Canna bud rot | Yellow to brown leaf spots, gummy stalks; decayed flowers | Discard diseased plants |
| **Carnation and Garden Pink** (*Dianthus*) | | |
| Aphid | Green lice | Malathion or lindane |
| Thrips | Foliage streaked, silvered | Malathion or lindane |
| Spider mite | Foliage yellow, dusty | Kelthane or Aramite |
| Fusarium wilt | Plants wilt from soil fungus entering via wounds | Remove diseased plants; put new stock in new location |
| Rust | Brown pustules on both sides of leaves | Spray with zineb; avoid wetting foliage |
| **Cherry, Flowering** (*Prunus*) | | |
| Scales, various | Shells over bark | Dormant oil or malathion for crawling stage |
| Tent caterpillar | Webby nests in tree crotches | Wipe out; spray with Sevin |
| Cankerworm | Inchworm caterpillars | Sevin or DDT |
| **Chinaberry** (*Melia*) | | |
| Citrus whitefly | Common in South; millions of white "moths" followed by sooty mold | Spray with malathion |

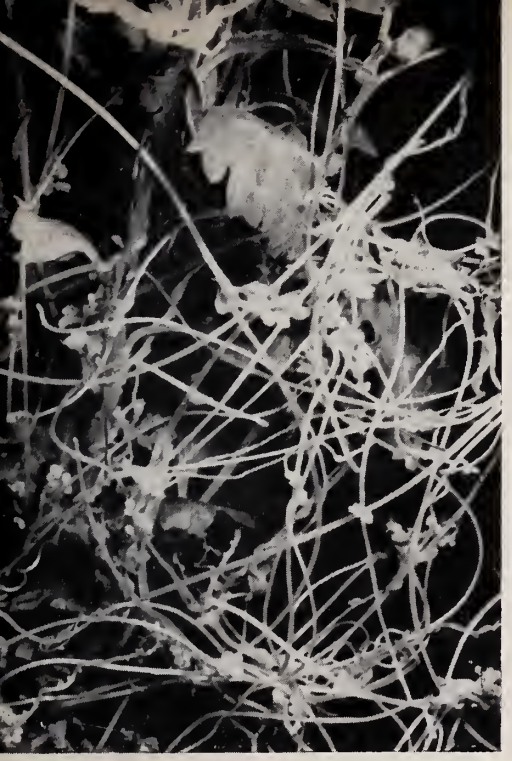


Tea scale on camellia leaf. *Left.* Lower surface. Dark bodies are female scale insects; light ones are male. *Right:* Effect of scale on leaf's upper surface.

| | | |
|---|---|---|
| **Chrysanthemum** (*Chrysanthemum*) | | |
| Chrysanthemum aphid | Large, dark-brown lice on terminal shoots | Malathion, lindane or Thiodan |
| 4-lined plant bug | Red nymphs; green adults with 4 black stripes make tan, depressed circles in new leaves | DDT or malathion |
| Chrysanthemum gall midge | Small conical galls in buds, stems, leaves | Lindane 3 times at 5-day intervals |
| Chrysanthemum lace bug | Leaves whitened | Lindane, malathion or Sevin |
| European corn and stalk borers | Plants wilting; stems break over | DDT or Sevin weekly in summer |
| Chrysanthemum thrips | Opening flowers deformed; leaves speckled white | Try malathion or dieldrin |
| Spittlebug | White, frothy masses; nymphs resembling leafhoppers | Cygon, lindane, methoxychlor or Zectran |
| Leaf nematode | Brown wedges in leaves, which die up the stem | Start plants from tip cuttings, not by dividing crowns; avoid overhead watering; use a mulch |
| Leaf spot | Small dark spots, starting on lower leaves | Spray with zineb, ferbam or Dithane M-45 |
| Dodder (a parasitic plant) | Orange tendrils and small white flowers | Remove infested plant parts before dodder sets seed |
| Verticillium wilt | One-sided wilting, dying | Remove diseased plants |
| **Clematis** (*Clematis*) | | |
| Blister beetle | Black beetles devour flowers, foliage | Sevin, DDT or lindane |
| Clematis borer | White caterpillar on fleshy roots, crowns; vines stunted | Treat base of plants with DDT |
| Root-knot nematode | Knots on roots; plants stunted, wilting | Remove infested vines; treat soil with Nemagon |
| Leaf spot, stem rot | Stems girdled near ground; upper portion dies back | Spray with captan, ferbam or zineb |

Blister beetles on flower of China-aster (Callistephus chinensis)

China-aster afflicted with aster yellows, a virus disease.



Dodder, a bright-yellow parasitic vine winding itself around chrysanthemum.

*Forsberg*

Various stages of verticillium wilt disease on chrysanthemum.

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| **Coleus** (*Coleus*) | | |
| Mealybug | Very common. *See* BEGONIA | |
| Whitefly | Myriads of small white "flies" or "moths" underneath leaves | Malathion, rotenone or lindane spray or dip |
| **Columbine** (*Aquilegia*) | | |
| Columbine borer | Salmon caterpillar in fleshy roots | Dust ground in spring with DDT or chlordane |
| Columbine leaf miner | Conspicuous white serpentine tunnels in leaves | Spray with lindane, malathion or DDT |
| Columbine skipper | Small green caterpillar eats, rolls leaves | As above |
| Aphids, many species | Plants stunted and sticky from honeydew | Malathion or lindane |
| **Cosmos** (*Cosmos*) | | |
| Spotted cucumber beetle | Flowers eaten by greenish beetle with 12 black spots | Malathion, DDT or methoxychlor |
| Japanese beetle | Feeds on flowers | Same as above, or Sevin |
| **Cotoneaster** (*Cotoneaster*) | | |
| Cotoneaster webworm | Ends of branches webbed, leaves skeletonized | Malathion and DDT when first noticed |
| Oystershell and San José scales | *See* LILAC | |
| Hawthorn lace bug | Leaves stippled | *See* HAWTHORN |
| Fire blight | Branches dying back | *See* CRAB APPLE |

Cedar-apple gall and its effect. *Left:* Pustules on leaves of crab apple, the alternate host. *Right:* The gall in its resting stage on red-cedar (*Juniperus virginiana*). For the spore-horn stage, see page 49.

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| **Crab Apple** (*Pyrus*) | | |
| Tent caterpillar | *See* CHERRY | |
| Cankerworm | *See* CHERRY | |
| Fire blight | Branches die back, appear scorched; bacteria inside | Prune out 6 inches below blighted portion; spray with streptomycin at early and full bloom |
| Cedar-apple rust | Clusters of orange cups on underside of leaves, fruit; native crabs especially susceptible; red-cedar alternate host | Remove galls from cedars in early spring. Spray crabs with ferbam or zineb weekly; replace native with Asiatic crab apples |
| Apple scab | Smoky spots on leaves | Ferbam or sulfur spray |
| **Crape-myrtle** (*Lagerstroemia*) | | |
| Crape-myrtle aphid | Shoots infested in early spring; much honeydew with sooty mold | Malathion, lindane or nicotine |
| Powdery mildew | White growth on young leaves which thicken but do not develop | Dormant lime sulfur before buds break or Karathane or Acti-dione later |
| **Crassula** (*Crassula*) | | |
| Mealybug | Stems, leaves, covered with small oval white cottony insects | Spray with malathion; syringe with water often |
| Cyclamen mite | Leaves rusty brown, rough; may die | Spray with Kelthane |
| **Cyclamen** (*Cyclamen*) | | |
| Cyclamen mite | Plants deformed, stunted, buds turn black | Spray with Kelthane |
| Black vine weevil | *See* BEGONIA | |
| Botrytis blight | Gray mold over blossoms, leaves; bulbs rot | Discard infected plants; spray with ferbam or zineb; reduce humidity |
| **Daffodil:** *See* NARCISSUS | | |

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| **Dahlia** (*Dahlia*) | | |
| European corn borer | Flesh-colored caterpillar in stems, which break over | Destroy old stalks, weeds, in autumn; dust or spray stems with DDT or Sevin |
| Stalk borer | Brown, white-striped caterpillar in stems | As above |
| Japanese and cucumber beetles | *See* COSMOS | |
| Potato leafhopper | Leaf margins brown, curled under; plants stunted | DDT on underside of foliage |
| Tarnished plant bug | Tips wilt, turn black; buds deformed; mottled brown bugs | DDT or malathion |
| Powdery mildew | White coating on foliage in late summer | Karathane or Acti-dione PM, or ignore |
| Dahlia mosaic or stunt (virus) | Yellow-green areas in leaves, margins uprolled; plants bushy | Take out infected plants; control aphid vectors |
| Dahlia ring spot (virus) | Rings or zigzags in foliage due to spotted wilt virus | Take out plant; use DDT to control thrips |
| **Daylily** (*Hemerocallis*) | | |
| Flower thrips | Flowers streaked or fail to open, foliage silvered; *See* ROSE | Try Cygon, DDT, lindane or malathion |
| **Delphinium** (*Delphinium*) | | |
| Cyclamen mite | Leaves greatly deformed, buds black, plants stunted; mites spread in handling, cultivating | Remove deformed plants; spray with Kelthane or Thiodan |
| Broad mite | Leaves appear glassy | Kelthane or sulfur |
| Delphinium aphid | Red lice on underside of cupped-down leaves | Lindane, malathion or nicotine |

Crown rot of delphinum.

Delphinium infested with mites.

Botrytis blight on flowering dogwood.

*Walker*

A fungal leaf spot of dracaena.

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| **Delphinium** (*continued*) | | |
| Slugs | Large holes in foliage, silvery trails | Metaldehyde bait or Zectran |
| Crown rot | Plants rot at crown, show reddish sclerotia and white fungus threads | Remove diseased plants and surrounding soil immediately; treat area with Terrachlor |
| Black spot | Bacteria cause tarry spots on foliage | Remove infected leaves; spraying rarely necessary |
| **Dieffenbachia** (*Dieffenbachia*) | | |
| Bacterial leaf spot | Yellow translucent spots covered with ooze; leaves wilt | Space widely; avoid syringing; try streptomycin spray |
| Leaf spot (fungal) | Small reddish-brown spots in young leaves | Same as above |
| **Dogwood** (*Cornus*) | | |
| Dogwood borer | White caterpillar works in cambium, killing branches and young trees | Dieldrin, DDT or Thiodan on trunk mid-May, mid-June |
| Dogwood twig borer | Yellow grub girdles twigs | Prune out and destroy |
| Leafhopper | Leaves whitened | DDT, Cygon, malathion or Sevin |
| Crown canker | Trunk girdled at base; fungus enters through wounds | Use wire guard to prevent mower injury |
| Botrytis blight | Gray mold on fading flowers, which rot onto leaves in wet weather | Zineb or Dithane M-45 at mid-flowering |
| Spot anthracnose | Tan spots with purple margins on flowers; gray spots with red margins on leaves | Zineb at bud-break and 10, 20 days later |
| Leaf spot | Brown spots with purple borders | Same as above |

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| **Douglas-fir** (*Pseudotsuga*) | | |
| Cooley spruce gall aphid | Alternate host; *See* SPRUCE | Spray with malathion or lindane |
| Bark beetle | Dark-brown or black beetles under bark | Improve tree vigor with food and water |
| Needle cast | Spotted needles turn yellow, brown, and drop | Copper spray as new growth develops |
| **Dracaena** (*Dracaena*) | | |
| Dracaena thrips | Leaves streaked, spotted | DDT and malathion |
| Leaf spot | Irregular brown spots with yellow margins | Remove infected leaves; keep foliage dry |
| Tip blight | Tips of leaves shrunken, pale | Same as above |
| **Elm** (*Ulmus*) | | |
| Elm leaf beetle | Leaves skeletonized by yellow and black larvae; holes eaten by greenish, black-margined beetles | Spray mid-May with lead arsenate, DDT or Sevin |
| Japanese beetle | Leaves skeletonized | As above but in July |
| Cankerworm | Inchworms or measuring worm | Sevin or DDT |
| Spider mite | Whitish or dusty foliage | Add Kelthane or Tedion to other sprays |
| Woolly elm and apple aphids | Purplish lice with white wool inside curled leaves and on bark | Lindane, malathion, Thiodan or diazinon |
| European elm scale | Soft brown scale with marginal fringe of white wax | Dormant oil, or malathion later |
| Dutch elm disease | Trees die, starting sometimes with a yellow flag; spores spread by bark beetles | Control beetles with strong dormant spray of methoxychlor or DDT; remove infected trees before May 1; plant resistant elms |
| Phloem necrosis | Trees die; phloem turns buttercup-yellow, wintergreen odor | Control leafhopper vectors |
| **Euonymus** (*Euonymus*) | | |
| Euonymus scale | Thin white males encrust stems, leaves; females scattered, brown | Malathion, Diazinon, or Cygon June and August |
| Bean aphid | Black lice | Malathion or lindane |
| Powdery mildew | White felt on leaves; common in South | Syringe off with water; dust with sulfur or spray with Karathane |
| Crown gall | Large irregular galls along stems, branches | No practical control; buy only healthy plants |
| **FERNS** | | |
| Scales (many species) | Thin flat yellow; greenish; large convex brown | Scrub with soap and water; spray with malathion |
| Fern aphid | Small, black, with white legs, common on Boston fern | Wash off or use malathion |
| Florida fern caterpillar | Green to black, feeding at night, in South | Hand-pick; spray with pyrethrum |
| Leaf nematode | Reddish to black bands on fronds | Burn infested plants |
| Anthracnose | Tips of fronds turn brown and dry | Remove diseased leaves; keep foliage dry |
| Tip blight | Gray spots, purplish margins | Same as above |

Shrub troubles. *Directly above:* Crown gall on euonymus. *Upper right:* Euonymus scale, a persistent pest. *Lower right:* Quince rust on hawthorn fruits.

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| **Fir** (*Abies*) | | |
| Bagworm | *See* ARBORVITAE | |
| Balsam twig aphid | White cottony insects on young shoots; tips curled | Spray with lindane in late spring |
| Spruce spider mite | *See* SPRUCE | |
| Tip blight | New tips yellowed, curled; twigs may die | Spray with Bordeaux, starting at bud break |
| **Firethorn** (*Pyracantha*) | | |
| Hawthorn lace bug | Common in South | *See* HAWTHORN |
| Pyracantha webworm | Leaves, shoots webbed together | DDT or lead arsenate |
| Fire blight | Branches die back | *See* CRAB APPLE |
| Pyracantha scab | Black scabs on leaves, fruit | Spray with ferbam at bud-break and 10, 20 days later |
| **Forsythia** (*Forsythia*) | | |
| 4-lined plant bug | Small tan circles in leaves | *See* CHRYSANTHEMUM |
| Stem gall | Small roundish galls along stem; common but not serious | Cut and burn infected stems if necessary |
| **Fuchsia** (*Fuchsia*) | | |
| Whitefly | Leaves yellowing, wilting, often with sooty mold | Spray with malathion |
| Mealybug | White ovals at leaf axils | Spray with malathion |

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| **Gardenia** (*Gardenia*) | | |
| Whitefly | Universal in South; leaves covered with sooty mold | Malathion or Cygon |
| Mealybug | White, cottony | Malathion or Cygon |
| Brown soft scale | Flat, green to brown | Malathion |
| Stem canker | Sunken brown lesions near base of stem | Do not syringe; take cuttings near top of plants |
| Bacterial leaf spot | Brown leaf spots, sometimes with yellowing and defoliation | Do not syringe plants |
| Bud drop | Occurs when plants are taken from garden or greenhouse to dry air of house | Increase humidity |
| **Geranium** (*Pelargonium*) | | |
| Aphids | Various species | Any aphicide |
| Whitefly, Mealybug | *See* BEGONIA | Spray with malathion |
| Spider mite | Dusty foliage | Malathion or Aramite |
| Botrytis blight | Gray mold on fading flowers, foliage | Spray with zineb; remove diseased parts; decrease humidity |
| Cutting rot (blackleg) | Black rot at base of stems | Start cuttings from healthy plants in sterile medium |
| Oedema | Swellings in leaves, corky ridges in petioles | Do not overwater |
| **Gladiolus** (*Gladiolus*) | | |
| Gladiolus thrips | Minute, slender insect; leaves silvered, flowers streaked | DDT, lindane or Cygon spray; dust corms before storage with 5% DDT or lindane |
| Flower and leaf blights | Flowers, leaves, stalks spotted, then blighted; corms rot | Spray weekly with zineb |
| Scab | Yellow to brown sunken lesions on corms; bacteria spread by soil insects | Dust corms before planting with Arasan-dieldrin mixture |
| Fusarium yellows | Soil fungus causes yellowing, wilting, death | Use resistant varieties |
| Dry rot (hard rot) | Brown spots on corms, husks | Discard infected corms |
| **Hawthorn** (*Crataegus*) | | |
| Hawthorn aphid | Young leaves curl around green lice | Spray early with malathion, lindane or diazinon |
| Rosy apple aphid | Leaves curled around pink lice with white wool | Dormant dinitro spray or malathion later |
| Woolly hawthorn aphid | White cottony masses on bark | Spray with lindane |
| Tent caterpillar | *See* CHERRY | |
| Cankerworm | *See* CHERRY | |
| Hawthorn lace bug | Leaves stippled white, rusty flecks on underside | Lindane, malathion, diazinon or Sevin |
| Hawthorn leaf blight | Small dark spots on leaves; defoliation in August | Zineb or Dithane M-45 at budbreak and 10, 20 days later |
| Quince rust | Papery white projections on fruit; fungus is perennial in red-cedar bark | Eliminate red-cedars or spray with ferbam or zineb |
| Hawthorn and cedar-apple rusts | Orange spots on leaves | Remove galls from red-cedars or spray hawthorn with ferbam-sulfur or zineb |

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| **Hemlock** (*Tsuga*) | | |
| Bagworm | *See* ARBORVITAE | |
| Spruce spider mite | Needles nearly white | Kelthane, Tedion or Cygon |
| Taxus and strawberry root weevils | Small white grubs feed on roots; dark adults notch needles at night; trees may die | Spray soil, plants with chlordane or dieldrin |
| Hemlock looper | Yellow, black-dotted caterpillars may defoliate | DDT and malathion in June |
| Hemlock scale | Gray circular shells; needles turn yellow | Cygon or malathion in early July |
| Fiorinia scale | Twigs whitewashed with waxy scales | Cygon in mid-May |
| **Holly** (*Ilex*) | | |
| Holly leaf miner | Blotch or serpentine mines in leaves; black flies emerge in late May | Spray with DDT after 2 to 4 new leaves open or use lindane, dieldrin, or diazinon in July |
| Southern red mite | Foliage dusty, often after DDT used for leaf miners | Aramite or Kelthane |
| Tea scale | White trailing scale common in South on Chinese holly | Spray with malathion; do not use Cygon on this holly |
| Tar spot | Yellow leaf spots turn reddish brown, then black | Ferbam at bud-break and 10, 20 days later |
| **Hollyhock** (*Althaea*) | | |
| Slugs | Large holes in foliage | Metaldehyde bait or Zectran |
| Japanese beetle | Common on flowers | Spray with Sevin |
| Spider mite | Foliage dusty, webby | Aramite or Kelthane |
| Hollyhock rust | Reddish pustules on underside of leaves, yellow spots on top and on stems | Dust with sulfur or spray with zineb; remove infected portions |
| **Honey-locust** (*Gleditsia*) | | |
| Mimosa webworm | *See* MIMOSA | |
| Honey-locust mite | Trees yellow, often defoliated | Spray with Aramite or ovex |
| Pod gall midge | Leaflets galled, shed prematurely; many broods | Spray with lindane |
| Honey-locust borer | Metallic black beetle; flathaded larva; tree girdled | Little practical control |
| **Honeysuckle** (*Lonicera*) | | |
| Aphid | Lice dense on new shoots | Malathion or other aphicide |
| Honeysuckle sawfly | Gray-green larvae with black spots; may defoliate | DDT, malathion or lead arsenate |
| **Horse-chestnut** (*Aesculus*) | | |
| Japanese beetle | Leaves chewed to lace | DDT, lead arsenate or Sevin |
| Tussock moth | *See* SYCAMORE | |
| Leaf blotch | Reddish-brown blotches; serious in wet seasons | Spray with zineb or Dithane M-45 |
| Leaf scorch | Caused by drought and heat | Water if possible |
| **Hyacinth** (*Hyacinthus*) | | |
| Bulb mite | Minute white mites in rotting bulbs | Discard infested bulbs |
| Bulb nematode | *See* NARCISSUS | |
| Soft rot | Bacterial, following mites | Discard soft bulbs |

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| **Impatiens** (*Impatiens*) | | |
| Spider mite (red-spider) | Webby foliage; common on plants indoors | Keep plants syringed off; use aerosol bomb |
| **Iris** (*Iris*) | | |
| Iris borer | Leaves ragged, water-soaked; large cream-colored larva hollows rhizomes | Clean up plant debris after frost; spray in spring with Thiodan, DDT or Cygon |
| Tulip bulb aphid | On bulbous iris | *See* TULIP |
| Flower thrips | On Japanese iris | *See* DAYLILY |
| Iris leaf spot | Oval brown spots on leaves | Spray with zineb or maneb; clean up in autumn |
| Soft rot | Vile-smelling bacterial rot following borers | Control borers; discard diseased plants |
| Crown rot | Common in hot humid weather | *See* DELPHINIUM |
| **Ivy, Boston:** *See* BOSTON-IVY | | |
| **Ivy, English** (*Hedera*) | | |
| Bean and ivy aphids | Purple, brown or black lice clustering on young tips | Malathion or nicotine, or pyrethrum bomb indoors; keep plants washed off |
| Spider mite | Leaves grayish, mealy or webby; serious indoors | Syringe with water; spray with Kelthane |
| Scale insects | Various species troublesome indoors | Provide a weekly bath; spray with malathion |
| Dodder | Common on outdoor ivy | *See* CHRYSANTHEMUM |
| Bacterial leaf spot | Greenish spots turn brown; stems shrivel and decay | Avoid crowding; spray with copper or streptomycin |

*Left:* Iris borer and its effect; the large pinkish larva at work. *Right:* Crown rot of iris, with resting bodies (sclerotia) appearing in abundance.

Iris leaf spot.

Effect of powdery mildew on phlox.

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| **Juniper and Red-cedar** (*Juniperus*) | | |
| Juniper scale | Very small round dirty-white scale; shrubs yellowish or gray | Dormant lime-sulfur spray or malathion for crawlers |
| Spruce spider mite | *See* SPRUCE | |
| Bagworm | *See* ARBORVITAE | |
| Juniper webworm | Brown webbed needles; brownish caterpillars | DDT and malathion May and August |
| Cedar-apple rust | Brown galls put out orange horns in spring; spores infect apple, crab apple, hawthorn | Cut off galls in winter or spray before horns form with Actidione |
| Nursery blight | Branches of seedlings and young trees die back | Remove infected plants or parts; spray with copper or phenyl mercury |
| **Kerria** (*Kerria*) | | |
| Japanese beetle | Prevalent on foliage | Sevin or DDT |
| Leaf and twig blight | Reddish spots with dark margins on leaves, stems | Spray with ferbam |
| **Lantana** (*Lantana*) | | |
| Whitefly | *See* AGERATUM | |
| Mealybug | *See* BEGONIA | |
| **Larch** (*Larix*) | | |
| Bagworm | Often defoliates | *See* ARBORVITAE |
| Larch sawfly | Trees defoliated by olive-green larvae with black tubercles | Lead arsenate or DDT |
| Woolly larch aphid | White woolly masses on needles | Spray with lindane |

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| **Larkspur, Annual** (*Delphinium*) | | |
| Delphinium aphid | Red lice thick between flowerets | *See* DELPHINIUM |
| Cyclamen mite | Buds deformed, black | *See* DELPHINIUM |
| **Leucothoë** (*Leucothoë*) | | |
| Leaf spot | Disfiguring spots on leaves | Control seldom practical |
| **Lilac** (*Syringa*) | | |
| Oystershell scale | Small oyster-shaped gray to brown shells on bark; very common | Dormant oil in early spring or malathion for crawlers, late May or early June |
| San José scale | Very small round grayish scales | Same as above |
| Lilac borer | Sawdust coming out of holes in trunk; limbs dying | Dieldrin or DDT on bark about May 1 |
| Giant hornet | Very large wasp, banded with yellow, girdles limbs by tearing off bark for nests | Sevin or lindane on bark in late summer |
| Powdery mildew | White coating on leaves late in the season; disfiguring more than damaging | Acti-dione PM or Karathane spray; or ignore |
| **Lily** (*Lilium*) | | |
| Aphids (various species) | Yellow-and-black or green lice infest buds, transmit mosaic | Spray with malathion, lindane or Thiodan |
| Botrytis blight | Oval tan spots grow together, leaves turn black, droop; most serious on Madonna lilies | Bordeaux or other copper spray |
| Virus diseases (fleck, mottle, streak) | Leaves mottled, plants stunted; virus can be carried in bulbs but not seed | Buy virus-free bulbs or grow from seed in isolated location; take out diseased plants; control aphid vectors |
| **Linden** (*Tilia*) | | |
| Linden leaf beetle | Yellow-and-green beetles, cream-colored grubs, chew ragged holes in leaves | Lead arsenate, methoxychlor or Sevin |
| Japanese beetle | Linden a preferred host | As above |
| Spider mite | Dusty-looking foliage | Add a miticide to beetle spray |
| **Locust** (*Robinia*) | | |
| Locust borer | Large yellow-and-black beetle tunnels in bark; trees may die | Spray trunk with dieldrin or DDT about May 1 |
| Locust leaf miner | Large brown blotches on leaves caused by a beetle | Lead arsenate in April or lindane or malathion in July |
| **Lupine** (*Lupinus*) | | |
| Lupine aphid | Large and green, covered with white powder; dense on stems, flower buds | Spray with malathion, lindane or nicotine |
| **Magnolia** (*Magnolia*) | | |
| Magnolia scale | Large convex soft brown scale; crawling stage in August; copious honeydew and sooty mold | Kill nymphs in April or September with malathion; scrub off adults |
| Tulip-tree scale | Similar to above | Cygon or malathion for young scales in late summer |

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| **Maple** (*Acer*) | | |
| Norway-maple aphid | Large and hairy, green to brown, dropping honeydew onto sidewalks and parked cars | Lindane, malathion, Thiodan or diazinon |
| Cankerworm | *See* CRAB APPLE | |
| Cottony maple scale | Brown with white cottony egg mass | Malathion in summer; avoid dormant oils on some maples |
| Verticillium wilt | Limbs on one side die, or the whole tree; vessels become black | Remove tree; do not replant with maple in the same location |
| **Marigold** (*Tagetes*) | | |
| Japanese beetle | Flowers, foliage devoured; on African, not French marigold | Try Sevin |
| Botrytis blight | Gray mold on fading flowers in wet weather | Keep old flowers cut off |
| **Mimosa** (*Albizzia*) | | |
| Mimosa webworm | Small brown caterpillars web, skeletonize leaves; tree appears scorched | Lead arsenate, malathion, lindane, Sevin, mid-June and mid-August |
| Mimosa wilt | A killing disease in the South and north to N. J., due to a soil fungus | Use resistant varieties |
| **Monkshood** (*Aconitum*) | | |
| Cyclamen mite | Commonly deforms flowers | *See* DELPHINIUM |
| Crown rot | *See* DELPHINIUM | |
| Verticillium wilt | Stalks die; vessels are black | Destroy; put new plants in new location |
| **Mountain-ash** (*Sorbus*) | | |
| Japanese beetle | Skeletonizes leaves | Try Sevin |
| Mountain-ash sawfly | Green larvae with black dots eat everything but leaf veins; work in upper part of tree | DDT or malathion |
| San Jose scale | *See* QUINCE, JAPANESE | |
| Aphids | *See* HAWTHORN | |
| Apple-tree borer | Larva bores near base; young trees killed | Spray trunk with DDT 3 times, starting mid-May |
| Fire blight | *See* CRAB APPLE | |
| **Mountain-laurel** (*Kalmia*) | | |
| Rhododendron lace bug | Leaves stippled gray | *See* RHODODENDRON |
| Rhododendron borer | *See* RHODODENDRON | |
| Leaf spot and leaf blight | Spots or blotches on foliage in shade | Ferbam at bud-break and 10, 20 days later |
| **Narcissus and Daffodil** (*Narcissus*) | | |
| Narcissus bulb fly | Eggs laid on ground; fat yellow maggot develops in rotting bulbs | Dust trench and bulbs with 5% chlordane before planting; discard soft bulbs |
| Bulb nematode | Dark rings in bulbs; growth abnormal | Discard infested bulbs; commercial growers treat with hot water |

Powdery mildew on lilac leaf.

Blasted bud of peony.

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| Basal rot | Chocolate-brown rot at base of bulb scales | Discard bulbs with rot |
| Leaf scorch | Red, yellow or brown spots near tips of leaves | Spray with zineb |
| Narcissus mosaic | Mottling, streaking, deformity | Remove diseased plants |
| **Nasturtium** (*Tropaeolum*) | | |
| Bean aphid | Black lice densely congregated on underside of leaves and on stems | Malathion, lindane or nicotine directed from underneath |
| **Oak** (*Quercus*) | | |
| Cankerworm | At peak of cycle trees nearly defoliated | Lead arsenate, DDT or Sevin in early May |
| Golden oak scale | Pits in bark; young trees may die | Malathion plus DDT, mid-June |
| Oak leaf miner | Blotches in leaves | Lindane, Sevin or malathion |
| Oak leaf roller | Trees may be defoliated | DDT or malathion, early May |
| Oak lace bug | Foliage whitened in mid-summer | Malathion, lindane or Sevin |
| Oak mite | Mottled yellow or dusty foliage | Add Aramite or Keithane to other sprays |
| Galls | Many species of wasps cause leaf and twig galls | No practical control |
| Oak wilt | Trees wilt and die; present in many states, but not yet reported from New York | Remove infected trees |
| **Oleander** (*Nerium*) | | |
| Aphids | Black, yellow or green lice on new shoots | Malathion or other aphicide |
| Scale | Pale yellow circular scales | Malathion or summer oil |

Botrytis and its effect on peony. *Left:* Overwintering fungus bodies (sclerotia) on stem); *center:* the stem rotting from being infected with botrytis; *right:* gray mold phase of botrytis on peony flower.

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| **Pachysandra** (*Pachysandra*) | | |
| Euonymus scale | Common on pachysandra | *See* EUONYMUS |
| Oystershell scale | *See* LILAC | |
| Leaf blight | Brown areas in leaves, pinkish spore pustules | Spray with ferbam at bud-break and 10, 20 days later |
| **PALMS** | | |
| Scales, many species | Flat or round, brown, white or purple scales encrust leaves, stems; weaken plants | Keep foliage washed off; spray with summer oil or malathion |
| Palm leaf skeletonizer | Caterpillars feed under webs; leaves turn brown and die | DDT, lindane or chlordane every 2 months |
| **Pansy** (*Viola*) | | |
| Garden slug | Large holes in leaves | Metaldehyde or Zectran bait |
| Botrytis blight | Gray mold on crowded, too wet plants | Remove diseased plants; reduce watering |
| Violet scab | *See* VIOLET | |
| **Peony** (*Paeonia*) | | |
| Rose chafer | Tan, long-legged beetles on flowers | Spray with DDT |
| Flower thrips | Flowers ball; brown edges on petals | DDT, Cygon or malathion |
| Botrytis blight | Young shoots rot with gray mold, buds turn black, flowers blast; resting bodies (sclerotia) on old stems | Cut stalks at ground level in fall; burn tops in spring; spray with zineb or Dithane M-45 weekly to flowering |
| **Peperomia** (*Peperomia*) | | |
| Ring spot (virus) | Plants stunted, leaves distorted with yellow or brown rings | Do not propagate from diseased plants |
| Corky scab | Copper-colored, scabby swellings on lower surface | Reduce watering |

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| **Philodendron** (*Philodendron*) | | |
| Bacterial leaf spot | Leaves, stems blighted | Use care with cutting; spray with streptomycin |
| **Phlox** (*Phlox*) | | |
| Spider mite (red-spider) | Leaves yellow, mealy or webby on underside | Aramite, Kelthane or Tedion |
| Phlox plant bug | Orange-and-black bugs cause pale spots on leaves | Spray with malathion |
| Stem nematode | Plants stunted; stems swollen or cracked; leaves deformed; no flowers | Remove abnormal plants; treat soil with Nemagon |
| Powdery mildew | White felty coating on leaves, stems; numerous black dots of fruiting bodies | Karathane or Acti-dione PM |
| "Rust" | Leaves brownish, perhaps due to reduced water supply in old stems | Cut old stalks at ground level to encourage new growth |
| **Pine** (*Pinus*) | | |
| Sawflies (various species) | Gangs of larvae eat all needles off a branch except new tip | Lead arsenate, DDT or Sevin when they hatch |
| Pine shoot moth | Crooked, light-colored tips, with pitch. Common on Mugho and red pines | Break out infested tips before June or spray with DDT or Sevin April and July |
| Pine webworm | Needles webbed together | DDT or Sevin |
| White-pine weevil | Leader turns brown from grubs working at base | Remove infested leader; spray with lindane or DDT in early April |
| Pine needle scale | White, pear-shaped shells; branches turn yellow | Dormant lime sulfur or malathion for crawlers |

*Left:* Larvae of red-headed pine sawfly attacking a small branch, which (*right*) soon becomes denuded of foliage.

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| **Pine** (*continued*) | | |
| Pine bark aphid | White fluffs on trunk and underside of branches | Lindane, malathion or diazinon |
| Spittlebug | Nymphs feed on twigs under frothy spittle; Scots pine may be killed | Spray with lindane, chlordane or malathion |
| White-pine blister rust | Swollen white blisters rupture to release orange spores; needles turn brown | Remove alternate host (red currant) for 300 yards |
| **Pittosporum** (*Pittosporum*) | | |
| Aphids | Black lice on young shoots | Spray with malathion |
| Cottony-cushion scale | Fluted white sacs on twigs, leaves; copious honeydew and sooty mold | Spray with malathion |
| **Plantain-lily** (*Hosta*) | | |
| Garden slugs | *See* HOLLYHOCK | |
| Crown rot | *See* BUGLEWEED | |
| **Poinsettia** (*Euphorbia pulcherrima*) | | |
| Oleander, brown, soft and cottony-cushion scales | Yellow or brown flat scales or white cottony sacs | Spray with malathion or Cygon |
| Mealybug | White, powdery | As above |
| Cankers, stem and root rots | Stem lesions; rotting near ground level | Take cuttings from healthy plants; pot in sterile medium |
| **Poppy** (*Papaver*) | | |
| Aphids | Black or green lice clustered on leaves, stems | Malathion or other aphicide |
| Bacterial blight | Black spots on leaves, flowers; gummy exudate | Destroy plants; reseed in new location |
| **Primrose** (*Primula*) | | |
| Spider mite (red-spider) | Leaves yellow with webs; die down in summer | Kelthane, Tedion or Aramite |
| Garden slug | Holes in leaves | Metaldehyde or Zectran |
| Black vine weevil | Roots eaten by small grubs | Treat soil with chlordane or dieldrin |
| Botrytis blight | Gray mold in moist weather | Remove fading flowers; spray with zineb |
| **Privet** (*Ligustrum*) | | |
| Whitefly | Very common in South | *See* CHINABERRY |
| Privet thrips | Common in North; hedges gray and dusty | Malathion or diazinon |
| Privet mite | Leaves yellow to bronze | Aramite, Tedion, or Kelthane |
| White peach scale | Grayish scales at base of branches, which die | Dormant oil or malathion for crawlers |
| Anthracnose (dieback) | Twigs, main stems die; cankers at base | Cut out diseased portions; California privet quite resistant |

Lace bugs on rhododendron. *Left:* At work on leaf's lower surface. *Right:* Stippling effect on upper surface.

| | | |
|---|---|---|
| **Quince, Japanese** (*Chaenomeles*) | | |
| Aphids | Green, brown or black lice inside curled leaves | Spray with malathion |
| Japanese beetle | Leaves skeletonized | Spray with Sevin |
| Hawthorn lace bug | *See* HAWTHORN | |
| San José scale | Small round grayish, with nipple in center | Dormant oil or malathion for crawling stage |
| **Rhododendron** (*Rhododendron*) | | |
| Rhododendron lace bug | Foliage in sun stippled yellow; dark nymphs, lace-winged adults; brown flecks on underside of leaves | Spray with lindane, Cygon, malathion or Sevin about June 1; repeat in July |
| Rhododendron borer | Sawdust from holes in trunk; dying back | DDT or dieldrin 3 times: mid-May, 20, 40 days later |
| Azalea bark scale | White woolly scales on stems | Dormant lime sulfur or malathion |
| Black vine weevil | Notches eaten from leaf margins | Chlordane or dieldrin in soil |
| Sunburn and windburn | Brown or silvery spots on leaves | Provide windbreak |
| **Rose** (*Rosa*) | | |
| Rose scale | Round dirty-white scales on canes | Dormant lime-sulfur spray |
| Potato and rose aphids | Green or pink lice on buds, new shoots; flowers may be deformed | Lindane, malathion, Cygon or Thiodan |
| Rose leafhopper | Leaves stippled white in early spring, again in fall | DDT, malathion or Cygon |
| Rose-slug | Small velvety-green sawfly larvae skeletonize leaves | DDT, malathion or Sevin |
| Rose chafer | Tan beetle feeds on flowers in June | Spray with DDT |
| Japanese beetle | Oval, metallic green; eats flowers, foliage, July, August | Spray weekly with Sevin, methoxychlor, DDT or malathion; cut off fading flowers which attract beetles |
| Rose leaf beetle | Very small, shiny green to blue, on buds, foliage | Spray as above |
| Rose curculio | Red-and-black snout beetle drills holes in buds | Spray with DDT |
| Flower thrips | Minute, works inside petals, buds ball; petal edges turn brown | Try DDT, Cygon or malathion |

*McWhorter*

*Left:* Aphids on a rosebud. *Upper right:* Circles cut from rose leaves by leafcutter bee. *Lower right:* Injury by rose midge.

**Rose** (*continued*)

| | | |
|---|---|---|
| Rose midge | Young buds turn black; all bloom ceases | Spray bushes, soil with DDT; repeat in 10, 20 days |
| European earwig | Slender, dark, beetle-like insect with forceps at rear; eats flowers | Chlordane, Sevin, lindane or DDT |
| Leaf-cutter bee | Ovals and circles cut from leaf margins for nests | No practical control |
| Pith borer | Bee and sawfly larvae tunnel in pith | Cut canes below infested portion |
| Rose stem girdler | Spiral mines around canes, which split | Cut out swollen canes in spring |
| Raspberry cane borer | Double row of punctures around young canes | Cut out wilting shoots |

| | | |
|---|---|---|
| Spider mite (red-spider) | Leaves turn yellow, gray or rusty, with webs; bushes may defoliate | Include Aramite, Kelthane, Tedion or Cygon in all-purpose spray |
| Nematodes, many species | Dagger, meadow, root-knot and other nematodes cause sickly bushes | Inject Nemagon. or V-C 13, in holes around bush |
| Blackspot | Black spots with fringed margins on leaves, which may turn yellow and drop; some rose varieties defoliate, others are tolerant | Phaltan, maneb or Dithane M-45 weekly from time leaves expand to hard frost |
| Spot anthracnose | Light spots with reddish borders on leaves, canes | Spray as for blackspot |
| Cercospora leaf spot | Tan spots with purplish borders; common in South | Spray with maneb |
| Powdery mildew | Leaves curl, with white wefts or powder; flower buds deformed; most noticeable in late summer | Special spray of Acti-dione PM, Karathane or Pipron as soon as noticed |
| Rose rust | Orange pustules on leaves; black in winter in warm climates | Remove infected leaves; spray with zineb |
| Brown canker | Small white spots with reddish margins on canes, run together in large cankers | Cut out infected canes at spring pruning; avoid warm, moist winter protection |
| Stem canker | Smutty areas near wounds, frost cracks, pruning cuts | Always prune just above a bud; do not leave stub; avoid wounds |
| Crown gall | Large gall at crown with rough surface or small galls on roots; due to bacteria | Plant only healthy bushes; if a galled rose dies, replace soil or wait 2 years before replanting |

Leafhopper and its injury on a rose. *Left:* Stippling of rose leaf. *Right:* Minute insects which cause this effect, sucking on the lower leaf surface.

(*Additional rose photos on next page*)

**Rose-of-Sharon**
(*Hibiscus syriacus*)

| | | |
|---|---|---|
| Aphid | Black lice at tips | Malathion or other aphicide |
| Japanese beetle | On flowers, foliage | Sevin or malathion |

Blackspot on upper surface of rose leaf.

Japanese beetle on a rose.

Rose rust, showing on lower leaf surface.

Brown canker on rose cane; dead areas having purplish borders.

Rust fungus on underside of snapdragon leaves, with leaf at left turned yellow.

*Roche*

Hollyhock leaf bearing rust pustules on lower surface.

| | | |
|---|---|---|
| **Rubber-plant** (*Ficus*) | | |
| Florida red scale | Very small, round, red to black | Spray with malathion |
| Mealybug | Oval white cottony insect | Spray with malathion |
| Anthracnose | Tips or whole leaves yellow or scorched | Remove infected leaves; avoid too frequent syringing |
| Oedema | Rough corky swellings from too much moisture in too low light | Reduce watering in cloudy weather |
| **Sassafras** (*Sassafras*) | | |
| Japanese beetle | Sassafras a preferred host | Spray with Sevin |
| **Snapdragon** (*Antirrhinum*) | | |
| Cyclamen mite | Leaves thick, buds deformed | *See* DELPHINIUM |
| Snapdragon rust | Chocolate-brown pustules on underside of leaves, yellow areas above | Buy rust-resistant varieties or spray with zineb |
| Anthracnose and blight | Tan or gray spots on leaves, stems; plants wilt | Zineb, maneb or captan spray; clean up debris in fall |
| **Snowball** (*Viburnum*) | | |
| Viburnum aphid | Black lice tightly curl new leaves of common snowball | Substitute Japanese varieties; spray with malathion, Thiodan or lindane before leaves curl |
| **Spirea** (*Spiraea*) | | |
| Aphid | Many green lice on new tips | Malathion, lindane or nicotine |
| **Spruce** (*Picea*) | | |
| Eastern spruce gall aphid | Galls at base of new growth on Norway spruce open in summer to release aphids | Spray with lindane before growth starts in spring; repeat in September |
| Cooley spruce gall aphid | Elongate galls at tips of blue spruce | Spray as above; cut off galls before they open |
| Spruce spider mite | Needles gray, cobwebby; trees unhealthy | Spray with Tedion, Aramite or Kelthane |
| Spruce budworm | Caterpillars web needles together; terminals killed | Lead arsenate or DDT as growth starts |
| Spruce canker | Lower branches dying, often oozing pitch | Avoid wounds; cut out dead branches but not when wet |

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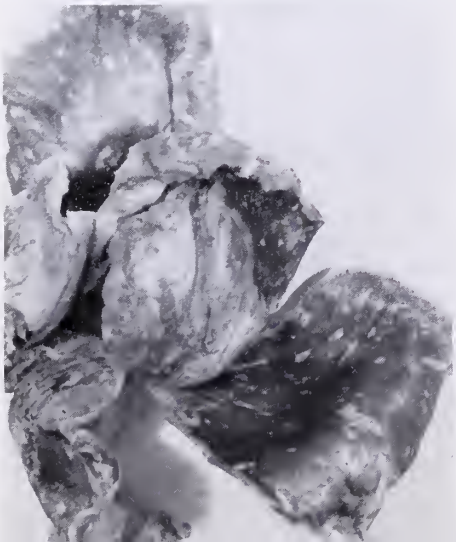
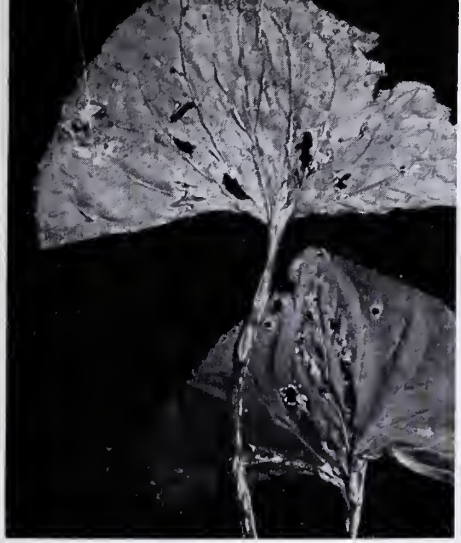
| **Sweet-William** (*Dianthus barbatus*) | | |
| Fusarium wilt | Plants wilt, turn yellow, often die from soil fungus | No control except to plant in a new location |
| **Sycamore** (*Platanus*) | | |
| Sycamore lace bug | Leaves whitened in midsummer | Malathion or lindane |
| Giant aphid | Very large, gray and black | Malathion or lindane |
| Tussock moth | Tufted hairy caterpillars, often dropping on sidewalks | Lead arsenate or DDT |
| Anthracnose | Foliage severely blighted in wet springs; cankers formed on twigs | Phenyl mercury spray as buds swell |
| Canker stain (on London plane) | Shrunken cankers on limbs; trunk; trees killed; spores spread in tree paint | Prune only in winter and if obligatory. Use gilsonite varnish with 2% phenyl mercury nitrate as wound dressing |
| **Tree-of-Heaven:** *See* AILANTHUS | | |
| **Tulip** (*Tulipa*) | | |
| Tulip bulb aphid | Powdery white or gray, common on stored bulbs | Dust with 1% lindane before storing |
| Green peach and other aphids | Transmit virus diseases | Lindane or malathion |
| Botrytis blight (fire) | Plants stunted, buds blasted, white patches on leaves; petals spotted with gray mold; small black sclerotia formed as petals rot into ground | Discard bulbs with dark specks of sclerotia; plant new bulbs in new location; spray with zineb or ferbam, starting early spring; cut off fading flowers |
| Cucumber mosaic | Yellow streaking or flecking of foliage | Do not grow tulips near cucurbits or gladiolus |
| Lily mottle viruses | Cause broken flower colors, mottled foliage | Do not plant near lilies; keep variegated tulips away from plain colors; control aphids |

Botrytis blight on tulip. *Left:* On flower; *right:* On leaf.





Violet scab, or spot anthracnose.

Taxus mealybug on a branch of yew.

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| **Tulip-tree** (*Liriodendron*) | | |
| Tulip-tree aphid | Green lice secreting much honeydew, followed by sooty mold | Lindane or malathion |
| Tulip-tree scale | Large brown shells over branches; trees weakened | Dormant oil or malathion or Cygon in late summer |
| **Verbena** (*Verbena*) | | |
| Verbena budmoth | Small greenish-yellow caterpillar feeds on new shoots, which wilt | Cut off wilting shoots |
| Verbena leaf miner | Blister and blotch mines in leaves | Spray or dust with lindane |
| **Violet** (*Viola*) | | |
| Garden slug | *See* HOLLYHOCK | |
| Spider mite | *See* PRIMROSE, ROSE | |
| Violet sawfly | Small black or green larvae on foliage at night | DDT, lead arsenate or malathion |
| Spot anthracnose (violet scab) | Red spots with white centers become tan raised scabs on stems, leaves | Remove and burn infected parts; spray with zineb or maneb |
| **Virginia-creeper** (*Parthenocissus*) | | |
| Virginia-creeper leafhopper | Foliage stippled white, especially in late summer | Spray with DDT |
| Japanese beetle | Lace-like holes in foliage | Spray with DDT |
| Eight-spotted forester | Foliage eaten by white caterpillars marked with black and orange | DDT or lead arsenate |
| **Willow** (*Salix*) | | |
| Aphids | Black lice prevalent on weeping willow | Malathion or lindane |
| Willow leaf beetle | Metallic blue beetles, dark slug-like larvae skeletonize foliage | DDT, Sevin or dieldrin |
| Poplar-and-willow borer | Rough swollen branches | Dieldrin in late August |

Powdery mildew on zinnia.

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| **Willow** (*continued*) | | |
| Willow scurfy scale | Small, pear-shaped, white; may kill branches | Dormant oil, or malathion in May |
| Willow blight (scab and canker) | Leaves turn black; branches wilt and die | Prune out dead material; 3 copper sprays may help |
| **Yew** (*Taxus*) | | |
| Black vine, or Taxus, and strawberry root weevils | White grubs on roots; dark wingless snout beetles notch foliage at night; new shrubs may die | Dieldrin or chlordane on soil and lower foliage when adults emerge in June |
| Taxus mealybug | White cottony insects covering trunk and interior branches | Malathion or Cygon |
| Taxus bud mite | Needles distorted | Spray with Thiodan |
| Dieback | Shrubs yellow in too acid, too wet soil | Increase pH to 6.5; improve drainage |
| **Zinnia** (*Zinnia*) | | |
| Japanese beetle | Feeds on flowers, foliage | Sevin, DDT or lead arsenate |
| Powdery mildew | White coating in late summer | *See* PHLOX |
| Leaf spot | Red-brown leaf spots with light centers; dark cankers on stems | Weekly spray with ferbam or Dithane M-45 |

# PESTICIDES FOR HOME GARDENS

*A guide to their safe use*

Louis Pyenson

PESTICIDES are often the only means of controlling insects and disease-producing organisms that attack plants. But because many can also harm man and animals, their selection should be made with maximum safety in mind without sacrificing adequate control.

A physician prescribes drugs for human ailments, but no responsible person would take them without reading the directions and following them explicitly. Similarly, the responsible gardener, having learned from a reliable source how to treat his ailing plants, should not attempt to use prescribed pesticides without reading and following all directions and precautions on the labels. Both drugs and pesticides, and for that matter all chemicals, are safe only when used according to directions. The indiscriminate use of pesticides can be highly dangerous to man and wildlife. This means that they should be kept out of the hands of children, the careless, and the uninformed.

## Pesticide Dangers

The potential danger of chemical pesticides to human beings and wildlife has received much publicity. There is a demand for safe prescriptions for pest control. The public should have the information that some pesticides involve no hazard to any forms of life except those causing the trouble; that others will safeguard the plants yet hold to a minimum the danger to humans, pets and wildlife; and that still others can be deadly if not used with proper precautions. Fortunately there is an ample number of relatively safe chemical pesticides to keep plants healthy.

Pesticide dangers should be considered from two viewpoints—the danger to the gardener who handles and applies the chemical; and the hazard to humans, pets and wildlife that may be exposed to them in water, food or air. Every gardener should be aware that pesticides may be harmful in a number of ways:

(1) by swallowing enough to produce toxic symptoms;
(2) by absorbing enough through the skin to produce injury or death; and
(3) by breathing in a harmful amount of the vapor or dust.

In addition the gardener should be aware that frequent or daily exposures to some pesticides, although they may not harm one at the time, may eventually cause poison symptoms. This toxicity may result from the accumulation of small doses of the pesticides in the body until symptoms of poisoning appear; or from frequent exposures with cumulative effects, each exposure producing more injury or sensitivity until severe symptoms appear. The chlorinated hydrocarbons such as DDT, lindane, chlordane, dieldrin and endrin tend to accumulate in the body fat; whereas the organic phosphate compounds such as parathion, TEPP, demeton, dimethoate and thiodan tend to produce cumulative effects by progressively inhibiting the function of the enzyme cholinesterase in the blood.

## Government Restrictions

The Federal Government by means of the Miller Bill, or Public Law 518, attempts to safeguard the public from the indiscriminate sale of pesticides by having potential pesticides meet definite requirements before a label can be approved for marketing them. For the protection of the consumers, a *tolerance* must be established for each pesticide on each food crop on which it is to be used. The amount allowed, given in parts per million (ppm), is generally 100 times less than the amount that will produce acute or chronic symptoms of poisoning. The

safe tolerance level is also protected by directions indicating the number of *days before harvest* that it is safe to apply the last spray on a particular food crop without leaving harmful residues. Some pesticides may be applied right up to harvest with complete safety to the consumer, some require up to 30 days or more before harvest for a good safety margin, and some should not be applied at all after the eatable parts form.

Highly toxic pesticides have the word POISON, the skull and crossbones, and a warning statement on the label. Even a taste may be deadly. Less toxic ones have a warning statement only; mildly toxic ones bear the word CAUTION and a statement of the hazards; and those considered safe may have no caution or hazard statements since there is very little danger from normal uses and precautions. Gardeners should limit themselves generally to pesticides in the last two categories to avoid the possibility of harmful effects unless they are prepared to use *all the precautions* on the label.

## Safety Measures for Pesticide Use

Here are some general safety precautions to follow when applying pesticides in home garden areas:

(1) Avoid the use of highly hazardous pesticides when safe or slightly hazardous ones will do the job.

(2) Read the entire label before opening the container, *noting ALL warnings and cautions.*

(3) Avoid inhaling the vapor or dust from concentrated chemicals, especially when mixing them.

(4) Wear natural rubber gloves when handling insecticides and when spraying. If any is spilled on the skin, wash it off immediately.

(5) Use respirators for protection from dusts or mists during handling and application. But remember that their use is not a substitute for essential precautions. Field operators who may be exposed to small amounts of pesticides continuously during the day or for succeeding days should faithfully use respirators as a precaution. Should breathing become difficult, change filters twice a day or oftener.

(6) Always store pesticides in original container with label intact.

(7) Destroy empty containers immediately. Bury cartons or burn them, and keep away from the smoke.

(8) Keep out of way of dust or spray drift. Never smoke or chew while spraying. After spraying, wash hands and face before smoking or eating.

(9) Cover bird baths, dog dishes, fish ponds before spraying. Never leave pesticides open to children, pets, birds.

(10) Pour leftover spray into a gravel drive, over soil, or down a drain that does not lead to a stream or open area. Never leave puddles.

(11) Keep away from edible vegetables or fruits when spraying ornamentals.

(12) Wash clothing each day after use. Wear clean clothes each day.

(13) Follow the directions for "days before harvest" application when applying pesticides to food crops.

(14) Always carefully wash fruits or vegetables before eating or cooking them.

(15) Call your local physican as soon as poisoning is suspected or contact your Poison Control Center (look up "Poison" in your telephone directory, or call your local health department). Experts are available there to assist in case of pesticide poisoning.

## How Pesticides Are Used

Pesticides may be used to destroy insects, disease organisms and weeds in a number of ways:

(1) Applied to plants as water solutions, wettable powder suspensions, water emulsions, or dusts to be eaten by or to contact the pests.

(2) Applied to the soil in the same forms as above and also as granules or liquefied gases to kill by contact or ingestion.

(3) Liberated as fumes or expelled by heat into confined places such as greenhouses or chambers so that their vapors will destroy the pests present.

(4) Expelled as aerosols in the form of a fog, fine mist, or smoke from special containers or fog generating equipment either in confined areas or as floating space clouds to destroy pests.

(5) Mixed with food attractive to rodents or other pests in the form of poison baits and placed where the pests will be likely to feed on them.

(6) Fed to plants in small amounts to be absorbed through roots or foliage and translocated throughout the plants to kill insects feeding on their sap or tissues or to destroy disease organisms attempting to get started. This treatment is called chemotherapy and the chemicals involved are termed *systemic* insecticides or fungicides.

## Dormant Sprays

Dormant sprays are generally applied to trees and shrubs on mild sunny days in the late winter or early spring, before plant growth begins, to get a head start on some insect pests and plant diseases. Their purpose is to destroy the overwintering stages of such pests as scale insects, mites, aphids, and mealy bugs, before they begin activities. These sprays may reduce the number of sprays required during the growing season or they may make further spraying for some pests unnecessary.

The best general dormant spray for home gardeners to use is a 60- or 70-second "superior" miscible oil which forms a milky emulsion when mixed with water. The oil is available under a number of trade names. Its effectiveness may be enhanced by the addition of 1 tablespoonful of malathion per gallon of spray. The spray will destroy scale insects (especially soft or armored scales), red mite eggs and mealy bugs, but not aphid eggs.

Dormant lime-sulfur is recommended for pine needle scale and juniper scale, but should not be used close to houses, buildings and painted fences, bricks or stones, for they will be permanently blackened.

Dormant dinitro (DNC) sprays, available under such names as Elgetol, Krenite and Dinitro-Sol, are especially effective on armored scales and aphid eggs but not on red mite eggs. They are poisonous when swallowed, inflammable when dry, and temporarily discoloring to painted surfaces. They must therefore be used with proper cautions. The dormant dinitros are also fungicides and when sprayed on diseased plant parts or foliage under plants will help control such diseases as scab on apple, pear and peach, raspberry and rose cane diseases and blackspot of roses. They are usually not available in less than gallon containers, which is more than most gardeners need, so it may be best to plan aphid control with summer sprays.

## General-Purpose Formulations

Much time and effort can be saved by combining pesticides to take care of insects, mites and plant diseases all with one application. These combinations can be made in the sprayer at the time needed, or, under trade names, good ones can be purchased already combined and ready for dilution. Either way one has a choice of combinations depending on the plants requiring protection, the pests to be controlled and the safety requirements. Home-made general-purpose formulations also need a sticker-spreader (available under trade names). General-purpose formulations are applied at intervals of one week to a month to prevent or control infestations.

Some of the relatively safe combinations useful for specific plant groups are presented here for gardeners who like to make their own mixtures.

### General Purpose Formulation for All Plants

| | |
|---|---|
| Rotenone, emulsifiable concentrate | 1 tbsp. |
| Captan, wettable powder | 2 tbsp. |
| Sticker-spreader | mfr.'s directions |
| Water | 1 gallon |

This combination is close to being a completely nonhazardous formulation which will give acceptable control on all plants, including fruits and vegetables close to harvest when nonpoisonous residues are essential. However, rusts and powdery mildews are not controlled by the captan, so when these diseases are problems, 3 tablespoons of a wettable sulfur can be added to the mixture.

### General-Purpose Formulation for Garden Flowers and Ornamental Trees and Shrubs

| | |
|---|---|
| Malathion, emulsifiable concentrate | 1 tbsp. |
| Carbaryl (Sevin), wettable powder | 1 tbsp. |
| Folpet (Phaltan), wettable powder | 2 tbsp. |
| Kelthane, wettable powder | 1 to 2 tbsp. |
| Sticker-spreader | mfr.'s directions |
| Water | 1 gallon |

## *Selected Pesticide Prescriptions for Home Gardens with Safety Ratings* (left column) and Principal Uses (right column)*

*A. Relatively nontoxic; used with normal care, presents no hazards to man or animals.

B. Relatively low in toxicity and hazards; use precautions in handling the concentrated materials before dilution.

C. Moderate in toxicity and hazard; warning statements on label. May be absorbed readily through the skin; advisable to use protective clothing; observe number of days to harvest.

D. Highly toxic and hazardous; warning statements on label. Avoid all skin contacts and applications to edible plant parts unless residues are known to break down readily.

E. Extremely toxic and hazardous; skull and crossbones on label. Not listed or recommended for home gardeners.

### Insecticide Plant Sprays

| | |
|---|---|
| Bacillus thuringensis **A** (Bio-guard, Thuricide) | Cabbage worms, canker worms, tomato horn worms |
| Carbaryl **B** (Sevin) Cumulative effect; allow 3 days to harvest | Chewing and sucking insects; leaf miners, lacebugs, chinch bugs, DDT-resistant insects |
| Chlordane **C** Accumulates in the body; residue in soil 10 or more years | Lawn grub-proofing, soil insects, termites |
| DDT **C** Accumulates in body; allow 4 weeks to harvest | Leaf-chewers on ornamentals, Japanese beetles, holly and boxwood leaf miners |
| Diazinon **D** (Spectracide) Cumulative effect in body; allow 2 weeks to harvest | Leaf chewers, fruit borers, bagworms, leaf miners, chinch bugs |
| Dieldrin **D** Accumulates in body; allow 5 weeks to harvest; residue in soil 10 or more years | Lawn grub-proofing, soil insects, termites, tree borers, thrips, plum curculio |
| Dimethoate **D** (Cygon) Cumulative effect; do not use on food crops | Systemic for scale insects, leaf miners, aphids, European pine shoot moth and others |
| Endosulfan **D** (Thiodan) Cumulative effect; allow 4 weeks to harvest | Aphids, cyclamen mite, white fly, peach-tree borers |
| Lime-sulfur **A** | Dormant spray for scales, mites, apple scab |
| Lindane **C** (Isotox) Accumulates in body; allow 2 months on fruits; do not use on edible plant parts | Sucking insects, leaf miners |
| Malathion **B** Cumulative effect; allow 1 week to harvest | Most sucking and many chewing insects |
| Methoxychlor **B** Accumulates in body; allow 2 weeks to harvest | Chewing insects |
| Milky disease spore dust **A** | Applied to turf for Japanese beetle grubs |
| Naled **C** (Dibrom) Cumulative effect; allow 4 days to harvest | DDT-resistant species of insects |
| Petroleum oils **A** | Dormant spray for scales, mite eggs, mealybugs |
| Polyhedrosis virus **A** Not yet known to be available for home use | Cabbage looper, European pine sawfly |
| Pyrethrins **A** Very toxic to fish | Chewing and sucking insects on ripening fruit and vegetables |
| Rotenone **A** Very toxic to fish | Chewing and sucking insects on ripening fruits and vegetables |

This formulation is relatively non-injurious to man and animals provided normal safety precautions are used. However, methoxychlor (2 tablespoons) should be substituted for Sevin where blooms are frequented by bees, since Sevin is quite toxic to them. Both tetradifon (Tedion) or chlorobenzilate will give as good control of mites as Kelthane and may replace it in the formulation. Ferbam or zineb may replace folpet on ornamentals where rusts are a problem, but

### Miticide Plant Sprays

| | |
|---|---|
| Chlorobenzilate **B** Accumulates in body; allow 2 weeks to harvest | Long residual contact for all species of mites |
| Kelthane **B** Accumulates in body; allow 7 days to harvest | Same as above |
| Tetradifon **A** (Tedion) | Long residual contact for eggs and immature mite stages |

### Rodenticides

| | |
|---|---|
| Anticoagulants **C** (Fumarin, Pival Pivalyn, Prolin, warfarin) Keep out of reach of children and pets | In poison bait form or in drinking water placed in protected feeders where only rats and mice can enter |
| Thiram **B** (Arasan 42-S) Do not eat treated seeds or berries | A repellent to rabbits and meadow mice when applied to bark of trees and shrubs in early winter. Also repellent to birds and mice on seeds and berries |

### Soil Fumigants

| | |
|---|---|
| Mylone **B** Allow 2 to 3 weeks before planting | Nematodes, weeds, fungi and insects in garden soils |
| Vapam **B** Avoid skin contact; allow 2 to 3 weeks before planting | Same as above |

### Plant Disease Sprays

| | |
|---|---|
| Acti-dione **B** (Ferrated, PM & RZ) Allow 4 days to harvest | Rusts, powdery mildew, turf diseases |
| Bordeaux mixture **A** | Foliar diseases of ornamentals |
| Captan **A** | Many foliar and fruit diseases; seed treatment |
| Chloranil **B** (Spergon) | Seed treatment |
| Copper compounds **A** | Diseases of vegetables and small fruits |
| Dyrene **B** Do not use on edible plant parts | Turf diseases, some vegetable diseases |
| Ferbam **B** (Fermate, Ferradow, Karbam) Allow 1 week to harvest | Many diseases of fruits, vegetables and ornamentals |
| Folpet **C** (Phaltan) Do not use on edible plant parts | Powdery mildew, foliage diseases, blackspot of roses |
| Karathane **B** Allow 3 weeks to harvest | Powdery mildew |
| Lawn fungicides **B** (Fore, Caddy, Kromad, Formula Z) | Broad range fungicides for turf diseases |
| Maneb **B** (Manzate, Dithane M-22) Allow 1 week to harvest | Leaf spots and blights on vegetables and flowers; blackspot of roses |
| PCNB **B** (Terrachlor) | Soil application for club root on cabbage and related crops; other soil-borne diseases |
| Streptomycin **B** (Agri-strep, Agrimycin, Phytomycin) Do not use on edible plant parts | Fire blight of pears and apples; bacterial leaf spots |
| Thiram **B** (Tersan, Arasan, Thylate) Allow 1 week to harvest | Lawn diseases; seed treatment, foliage diseases |
| Zineb **B** (Parzate, Dithane Z-78) Allow 1 week to harvest | Vegetable and flower rusts; leaf spots and blights |

powdery mildew will not be controlled unless one-half tablespoon of Karathane or Mildex is added.

For fruits, ferbam or thiram (thylate), 2 tablespoons per gallon of water should replace folpet. Where powdery mildew needs to be controlled, one-half tablespoon of Karathane should be added. Substitute methoxychlor (3 tablespoons) for Sevin on apples in the 3-week period following full bloom, as otherwise

(*Concluded on page* 54)

# DISEASES OF ORNAMENTAL PLANTS

## *Their nature and methods of control*

J. T. Walker

IMPORTANT in the consideration of plant disease control is the realization that diseases don't just happen; they are the result of a causal agent or agents acting on the plant in conjunction with the environment. If the cause or causes can be determined early and accurately, then measures for control can be initiated to eliminate or at least to minimize the disease. Most plant diseases are caused by parasitic fungi, bacteria, nematodes or viruses. Some result from physical or nonparasitic factors, such as unfavorable growing conditions, presence of chemical weed-killers, or a deficiency or excess of nutrients, moisture or light (see page 92).

### Fungi and Bacteria

Since the majority of parasitic diseases of ornamental plants are due to pathogenic fungi, it will be helpful to know what a fungus is like. The main body of a fungus is composed of numerous threads (*hypha*, singular; *hyphae*, plural), which in mass are called *mycelium*. The fruiting bodies, or *spores*, are borne on or in specialized structures arising from the hyphae, and the spore type is used in the classification and identification of fungi. An astronomical number of spores can be produced in a favorable environment. As the spores germinate, they form new hyphae. Subsequently, spores from these complete the cycle. Leaf spots, leaf blotches, mildews, rusts, as well as some blights and wilts are caused by different species of fungi which invade plant tissue and exist at the expense and to the detriment of the host plant. If the fungus lives only on living plants it is called a *parasite;* if only on dead material, a *saprophyte*. Many pathogenic fungi are capable of living on both.

Some species of bacteria are plant pathogens (capable of inciting disease), and are the cause of such serious diseases as fire blight, bacterial wilts, and bacterial leaf spots. These single-celled microscopic organisms obtain their nourishment from the plants and rapidly reproduce by division inside plant tissue. They are spread by insects, wind-blown rain, and man.

### Effects of Viruses

Viruses are also responsible for initiating many diseases of ornamental and agriculturally important plants. These ultramicroscopic entities, too small to be seen with the ordinary light microscope, are composed of a protein sheath around a strand or core of ribonucleic acid. They are replicated only within the living cells, having gained entrance mainly by insects (aphids and leafhoppers), nematodes or wounds. A few are transmitted in seeds. Many virns-caused diseases go undetected because the symptoms are not always obvious or the disease does little harm. To many growers the tulip-breaking disease, which results in "parrot" tulips, is a desirable virus affliction. Other virsuses, however, causing patterns of green and pale green tisue (mottling), chlorosis, stunting, or even death, are less desirable.

### Other Living Organisms That Inflict Disease

Nematodes (see page 55), certain insects, and some parasitic flowering plants sometimes cause plant diseases. Generally, insects feeding on plants cause injuries rather than diseases, but certain gall-making insects so disrupt the plant's metabolism that they are considered disease-causing agents. Parasitic plants like dodder (*Cuscuta*) and witchweed (*Striga*

*lutea*) may also seriously reduce the growth and vigor of their host plants, thereby bringing about disease.

## Influence of Environment

The nonparasitic factors which cause diseases are not always easy to ascertain. Plant species or even varieties differ in their sensitivity to environmental factors just as they differ in susceptibility to a particular disease-causing organism. If the environmental conditions have changed or been alleviated since the initial appearance of symptoms, diagnosis may become difficult. Often not enough is known about the influence of slight changes in gardening practices, or people may have forgotten exactly what they did to the plant. Awareness of growing conditions, cultural practices and treatment is a necessary background to the diagnosis and evaluation of plant diseases. Once this information is completed, then control measures can be suggested and undertaken, thereby treating the cause and not merely the symptoms.

## Preventive Programs

In situations where diseases are known to occur year after year on particular plants, a preventive disease-control program may be required. This may mean excluding potential disease organisms by the use of sterilized soil, resistant varieties, protective sprays, or proper cultural practices, or by conscientiously observing plants before planting for any signs of disease. A change in cultural practices is sometimes necessary to alleviate nonparasitic diseases.

Once a disease is established or becomes epidemic, then attempts to eradicate or control it by dusting, spraying, or removal of the diseased material become paramount.

In the list that follows, some typical diseases of cultivated plants are described and remedial measures for them are recommended. For some of the more common troubles of a greater number of garden plants, see the chart that begins on page 6. This includes problems caused by insects, nematodes, and other animal pests, physiological diseases (such as water spots on African-violet leaves), and viruses, as well as diseases caused by fungi and bacteria. Both lists are alphabetized by common names of plants.

For further help, excellent textbooks and other references are to be found in libraries, also in County Agricultural Extension offices. These should be consulted for additional information.

## Some Typical Diseases of Specific Plants

### *African-violet* (*Saintpaulia ionantha*)

**Botrytis blight.** Under low light and high humidity, leaves and petioles may become water-soaked and rotten. As more leaf area becomes affected, the fungus *Botrytis cinerea* forms masses of gray spores on the decaying surfaces. Leaf tissue turns from brown to black and leaves droop or fall from the plant.

*Treatment:* Remove diseased tissue. Increase ventilation by leaving more space between plants. Spraying with captan or Botran may be necessary.

**Root and crown rot.** Sudden wilting of leaves or rotting of plant at soil surface may be the result of infection by the fungus *Pythium ultimum*. Similar symptoms caused by high applications of fertilizer should not be confused with this disease.

*Treatment:* Avoid over-watering, use sterile rooting medium, sterile potting soil and clean pots to minimize chances of infection. Cuttings from healthy, non-discolored tissue may be taken for propagation of particularly valuable specimens.

### *Azalea* (*Rhododendron* species and varieties)

**Bud and twig blight.** This is a disease of flower and leaf buds; not to be confused with the petal blight mentioned above. The buds turn brown and shrink. Later the fungus (*Briosia azaleae*) may grow into the twigs, killing them. Repeated attacks may kill the plants in a few years.

*Treatment:* Prune and burn affected branch tips. Monthly sprays with a fungicide containing copper may prevent invasion of new buds.

**Chlorosis.** Leaves become yellow, first between veins, especially when plants are growing in alkaline soils or too near limestone foundations.

*Treatment:* Iron chelates can be sprayed

*Forsberg*

Bacterial leaf spot of begonia.

on foliage, or applied to soil. Ferrous sulfate, 1 pound per gallon, can be poured around the shrubs, but should be kept away from stems.

**Wilt and root rot:** *See* RHODODENDRON.

## *Begonia* (*Begonia*)

**Bacterial leaf spot.** Small blister-like translucent spots with yellowish margins on leaves are caused by the bacterium *Xanthomonas begoniae*. As these spots coalesce and turn brown, leaves often fall.

*Treatment:* Completely destroy spotted leaves. Avoid crowding plants to increase air circulation.

**Powdery mildew.** The familiar dusty white coating on leaves, stems and flowers of many plants, including begonia, is due to one of the powdery mildew fungi. The disease develops under moist conditions.

*Treatment:* Use sulfur or karathane sprays.

**Oedema.** Sometimes called corky scab, this physiological disorder is caused by overwatering in cloudy weather. The corky out growths appear on the lower side of leaves and along the stems of peperomias and other plants as well as begonia.

## *Boston-ivy* (*Parthenocissus tricuspidata*)

**Leaf spot.** Brown angular spots with black pin-point fruiting bodies in the center appear during the rainy season on Boston-ivy attacked by the fungus *Guignardia bidwelli*. The disease is also found on Virginia-creeper and grape.

*Treatment:* Remove spotted leaves when possible and spray diseased plants with a copper or carbamate fungicide.

## *Boxwood* (*Buxus sempervirens*)

**Decline or dieback.** Branches in the middle or top of boxwood first become gray-green, then bronze and finally straw-colored. The disease is associated with winter damage or poor drainage.

Boxwood is also subject to several serious diseases caused by fungi: Volutella blight or canker, leaf blight, and leaf spots. Removal of dead branches and leaves, along with sprays of Bordeaux or lime-sulfur, will usually control them.

## *Calla-lily* (*Zantedeschia aethiopica*)

**Root rot and soft rot.** Root rot, caused by the fungus *Phytophthora*, brings about a yellowing of the leaf margins which progresses inward until the entire leaf may be affected. New roots rot at their tips, older roots become hollow. Bacterial soft rot disease causes the plants to wilt and die; roots and rhizomes become soft and slimy.

*Treatment:* For control of both diseases, cut out the rotted areas of the rhizomes, dry and then soak rhizomes for one hour in 2 per cent formaldehyde before planting. Do not overwater.

## *Camellia* (*Camellia*)

**Bud drop.** Loss of flower buds on greenhouse and indoor plants is usually due to unfavorable environment, and in many cases to overwatering of the soil.

## *Carnation* (*Dianthus caryophyllus*)

**Fusarium wilt.** One of the most serious diseases of carnation, this malady occurs almost everywhere, especially during warm summer months. The affected plants wilt, usually on one side, and become straw-yellow in color. The vascular system may be discolored.

*Treatment:* Outdoors, control is difficult. Indoors use "disease-free" cuttings and sterilized soil, and guard against recontaminating the soil.

Young seedlings are also affected by another species of *Fusarium* which causes a stem rot.

**Bacterial wilt.** Wilting of carnation without distortion of the plant may be caused by *Pseudomonas*, a bacterium. The stems of wilted plants may be discolored on the wilted side and, later, the tissue becomes soft. Most of the roots are so rotten that they remain in the soil when the plant is pulled. Both stems and roots may be sticky to the touch.

*Treatment:* The same controls suggested for Fusarium wilt likewise apply for control of bacterial wilt.

Carnations also are susceptible to stem rot, verticillium wilt, rust, septoria leaf spot, alternaria blight, botrytis blight, and many virus diseases.

## *China-aster* (*Callistephus chinensis*)

**Fusarium wilt.** One of the most common diseases is caused by the fungus *Fusarium oxysporum* f. *callistephi*. Lower leaves may wilt first, recover at night, then wilt again during the day. The stems of affected plants may show a brown discoloration when cut. Roots are generally rotten. Control is difficult, but some varieties of asters are resistant to some fungus strains. These should be planted wherever possible.

*Treatment:* Treat seeds with Semesan ust and avoid planting in soils where disase has previously been known to occur.

**Yellows.** This disease, which attacks many kinds of plants, is caused by a virus that is spread by leafhoppers and that may be harbored in weeds and such other flowers as chrysanthemum, calendula, marigold, petunia, phlox. The result is vein-clearing of leaves, stunting, and development of secondary shoots, often pale green or yellow, along the main branches.

*Treatment:* Spraying or dusting with DDT will reduce the insect vectors but not cure the disease. Rogue (dig) the diseased plants as soon as noticed.

## *Chrysanthemum* (*Chrysanthemum*)

**Foliar nematode** (*Aphelenchoides*). Symptoms of foliar nematode damage may resemble those caused by the leaf spot diseases except that the individual leaves are often distorted on the side that shows brown V-shaped tissue. These nematodes swim on wet leaf surfaces and invade the tissue, working upward from the lower leaves.

*Treatment:* Take cuttings from the tips of healthy plants and avoid replanting chrysanthemums in the same locations year after year. Use mulches to help prevent splashing water.

**Chrysanthemum stunt.** Although symptoms vary with different cultivars, plants are commonly stunted. Leaves may have yellow bands along the veins, curl upward on margins, or have diffuse pale spots. Flowers may be paler than normal. Some varieties can be hosts without having any distinct symptoms.

*Holmes*

**Foliage symptoms of yellows virus on China-aster, showing vein clearing.**

*Treatment:* Rogue (dig) diseased plants, and keep plants free of leafhoppers to control all virus diseases.

Other viruses of chrysanthemum include yellows, mosaic, aspermy, and tomato spotted wilt.

## *Coleus* (*Coleus*)

**Black leg.** Stem cuttings of potted plants sometimes become darkened because of a soil fungus, either *Pythium* or *Rhizoctonia*.

*Treatment:* Little can be done once the disease is present. To avoid it, use a sterilized rooting medium.

Coleus is also subject to attack by root-knot nematode and a virus.

## *Columbine* (*Aquilegia*)

**Stem rot.** Often called wilt because of the first noticeable symptom; also known as crown rot. *Aquilegia* may succumb to *Sclerotinia sclerotiorum*. Fungus hyphae can be seen near base of plant or on leaf petioles. Dark, hard, specialized masses of hyphae (*sclerotia*) are formed in and around plant stems and on soil. These are over-wintering bodies.

*Treatment:* Keep mulch away from plants to increase air circulation. Remove any diseased plants, and replace soil if necessary.

## *Cyclamen* (*Cyclamen*)

**Leaf spots.** Several fungi can cause leaf spots of cyclamen under humid conditions.

*Treatment:* Reduce humidity, provide more air circulation, dip plants in ferbam.

**Soft rot.** This frequently encountered bacterial disease can completely destroy a cy-

clamen plant once it is introduced. An affected plant may wilt suddenly with a collapse of entire petioles. The corm rots, but not the roots.

*Treatment:* Water with care, as the bacteria can be spread by splashing. Use sterilized soil and pots.

These attractive plants are also subject to botrytis blight (*see* AFRICAN-VIOLET), a fungus-caused stunt disease, and leaf nematodes.

## *Dahlia* (*Dahlia*)

**Wilt.** One or more leaves of the plant wilt, usually from the tip downward. The vascular bundles of the stem, when cut open, may be brown. The organisms (either *Fusarium* or *Verticillium*) may remain in the soil for indefinite periods.

*Treatment:* Treat soil with chloropicrin. Plant only sound, healthy tubers.

**Soft rot of stem.** This bacterial infection also results in wilting. Once a plant is infested, there is no cure.

**Stem rot.** This form of wilting is caused by the fungus *Sclerotinia sclerotiorum* (*see* COLUMBINE).

*Treatment:* Applications of Terrachlor to soil may retard development.

**Mosaic.** Sometimes referred to as stunt because of its effect, this virus-caused disease is transmitted by a species of aphid. If the leaves are chlorotic or have yellow areas along the main veins, or become puckered, then one must be suspicious of mosaic. Another virus disease of dahlia is spotted wilt or ring spot.

*Treatment:* Plants affected by any of these must be promptly removed and destroyed. Do not save suspect tubers unless they can be planted away from the main garden and protected with insecticides.

**Hopperburn.** This injury might be mistaken for stunt disease because leafhopper feeding may stunt the plant. Edges of leaves turn brown and die, and as the cells in the center grow, the leaves become puckered.

*Treatment:* Use malathion and DDT against the insects.

## *Delphinium* and *Larkspur* (*Delphinium*)

**Black leaf spot.** The bacterium *Pseudomonas delphinii* causes irregular black areas on leaves, which may rot under moist conditions. Bacteria remain in soil and on plant debris and are spread to leaves by splashing rain.

*Treatment:* Remove spotted leaves in fall. Bordeaux sprays (2-2-50) will sometimes check the disease.

**Stem or bud rot.** Another bacterial disease causes yellowing and wilting of leaves, also blackening of stems, which may become soft and slimy in moist weather.

*Treatment:* Avoid planting in low moist areas and use Bordeaux drenches on soil and plants.

Several other diseases, including fusarium wilt, sclerotinia wilt, diaporthe blight, powdery mildew, and aster yellows attack delphinium.

## *Dieffenbachia* (*Dieffenbachia*)

**Stem rot.** A water-soaked rotted area on the stem near the soil may be caused by the fungus *Phytophthora*. Extent of damage will depend on age of plant: young ones may wilt or turn yellow, older ones may not.

*Treatment:* Use sterilized soil for all cuttings, provide good drainage, and avoid high temperatures.

## *Dogwood* (*Cornus florida*)

**Bleeding canker or crown canker.** Perhaps the most serious problem, especially on transplanted trees, is the canker caused by a soil-borne *Phytophthora*. The fungus invades trees through wounds and may go undetected for some time before a dieback or general unthrifty condition is noticed. Leaves may be off-color and turn prematurely red. If the disease is undetected it may eventually kill the tree.

*Treatment:* If the canker is detected early, removing diseased tissue and painting the area with orange shellac and tree wound paint may prevent further development. Avoid injuring trees with lawn mowers or other equipment.

**Twig blight.** Several species of fungi may cause a dieback of dogwood twigs.

*Treatment:* Pruning some distance back from the dead twigs is the only practical control measure.

## *Euonymus* (*Euonymus*)

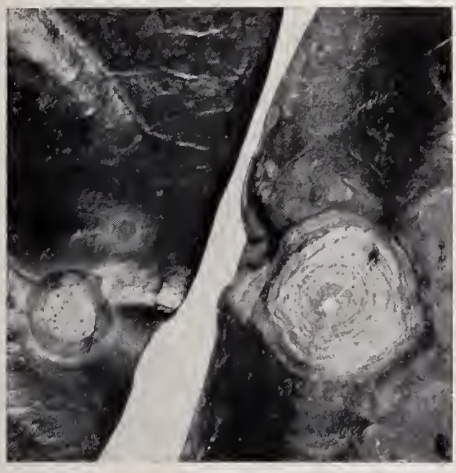
**Crown gall** (often called cancer disease). Irregular galls on roots or stems are caused by *Agrobacterium tumefaciens*, which invades tissue through wounds.

*Treatment:* Avoid wounding plants. Remove and destroy any plants with galled tissue.

## *Firethorn* (*Pyracantha*)

**Fire blight.** A sudden wilting of leaves as if scorched by fire is caused by the bacterium *Erwinia amylovora.* Leaves usually remain attached to the plant. Cotoneaster, pear, quince and apple (all, like firethorn, in the rose family) are also attacked. The organism remains in the affected tissue over winter, though it is inactive then.

*Treatment:* During bloom, and again after seven days, spray with streptomycin. In winter, remove affected areas by pruning well below them, using denatured alcohol to disinfect pruning equipment. Avoid using high nitrogen fertilizers.



*Forsberg*

Leaf spot of gardenia caused by the fungus *Phomopsis*.

## *Gardenia* (*Gardenia jasminoides*)

**Leaf spots.** Gardenia leaves may be infected by bacteria (*Pseudomonas*), also by fungi (*Rhizoctonia* and *Phomopsis*). A corky stem canker below the soil line is also caused by *Phomopsis.*

*Treatment:* Use steamed soil for propagation of cuttings and take them only from healthy plants. For *Pseudomonas* and *Rhizoctonia*, lower the temperature, pick off diseased leaves, and increase air circulation.

**Bud drop.** A common occurrence; flower-buds turn brown, rot and eventually drop off.

*Treatment:* Avoid excessive soil moisture and temperature fluctuations.

**Root knot.** Certain nematodes cause galls and swellings on roots. Plants so affected may wilt more rapidly under moisture stress than non-infested plants.

*Forsberg*

Bacterial leaf spot of geranium.

*Treatment:* Destroy infested plants. Prevent root knot from getting established by using sterilized soil and clean plants.

**Chlorosis.** Yellow leaves may be caused by cool soil temperatures, excesses or deficiencies of nutrients, and too alkaline soils.

*Treatment:* Check the soil pH often and if above 7.0 add iron sulfate, a tablespoon per bushel of soil. Iron chelates can also be used (*see* AZALEA).

## *Geranium* (*Pelargonium*)

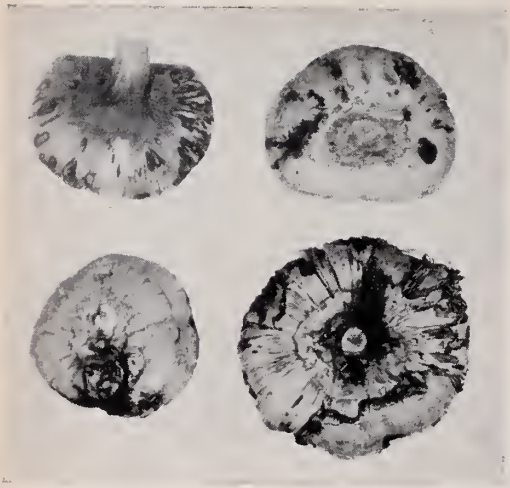
**Bacterial leaf spot.** Creating a serious problem with greenhouse plants, the bacterium *Xanthomonas pelargoni* causes a variety of symptoms, including water-soaked leaf spots with yellow margins, wilting of leaves, and stem rot. Cuttings of diseased plants may wilt and fail to root. The bacteria can survive in moist soil.

*Prevention:* Root geraniums only in sterilized soil.

**Oedema.** A nonparasitic disease which might be confused with bacterial leaf spot is associated with excessive soil moisture. Corky protuberances develop on leaf undersurfaces and petioles.

Oedema of geranium caused by overwatering.

*Forsberg*



*Gould*

Scab of gladiolus.

*Treatment:* Give plants less water and provide sufficient light and air.

Geraniums are also subject to many other diseases such as virus mosaic, botrytis, cercospora and alternaria leaf spots, spotted wilt, and the disease of cuttings called blackleg.

## *Gladiolus* (*Gladiolus*)

**Scab.** A bacterial disease of the corms causes dark sunken lesions with a yellow bacterial ooze which in time becomes dark and shiny. The organism is transmitted by a bulb mite. Under wet soil conditions the disease develops as a neck rot on the corms.

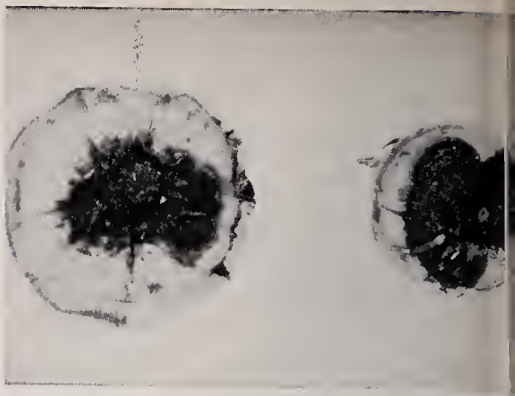
*Treatment:* Dust corms with a disinfectant at planting time as a preventive measure. Use a miticide to control the carriers of the disease.

**Corm rots.** Various other corm rots besides scab may affect gladioli. These diseases may also have an above-ground leaf phase, and in some cases even the flowers may be affected. Control measures for each have been worked out for the specialist, and information can be obtained from local agricultural agents.

*General treatment:* Examine all corms before planting, and plant only in well-drained locations.

**Virus diseases.** At least five different viruses are known to affect gladioli, and symptoms vary with each and with different varieties affected by the same virus.

*Treatment:* Remove all diseased plants and keep insects under control.



*Gould*

Basal bulb rot of gladiolus caused by fusarium.

## *Gloxinia* (*Sinningia speciosa*)

**Downy mildew.** Not to be confused with the powdery mildew of many plants, this disease causes wilting of leaves and stems. The first noticeable symptom may be brown water-soaked areas on leaves or stems. Roots may be discolored, and diseased corms become soft.

*Preventive:* Plant only in steamed soil.

**Boron deficiency.** Lack of boron in the soil can bring about necrosis at the base or tip of leaves. In severe cases, leaves wilt and plants die.

*Treatment:* Add 6 per cent boric acid solution to potted plants.

Mosaic and spotted wilt viruses, as well as a crown rot disease, are also known to occur on this close relative of African-violet.

## *Holly* (*Ilex*)

**Leaf spots.** Spots on holly leaves may result from several different fungi or from mechanical injury. Leaves having black raised areas resembling tar spots are invaded by the fungus *Phacidium*. Spots that result from mechanical damage may occur from ice on leaves or from puncturing by spines of other leaves. Purple halos usually surround such punctured areas, and occasionally secondary fungi may invade the tissue.

*Treatment:* For Phacidium spots, remove affected leaves. If the disease has been serious, sprays of dichlone, beginning in early spring, may be necessary. Other fungal leaf spots seldom require sprays. To

reduce wounding, plant holly in sheltered locations or provide wind protection.

### *Hydrangea* (*Hydrangea*)

**Powdery mildew.** Lower surface of leaves is covered with a light gray mold; upper surface often turns purplish. Flower buds may be deformed. The disease is perhaps more unsightly than harmful.

*Treatment:* Use sulfur, karathane or Actidione PM.

**Chlorosis.** Sometimes excess lime in the soil will cause a yellowing between veins.

*Treatment:* Increase acidity of soil with about one pound of aluminum sulfate per square yard.

Bacterial wilt, phyllosticta leaf spot, and botrytis blight may affect hydrangeas.

### *Iris* (*Iris*)

**Soft rot.** Dieback of leaf tips may indicate the presence of soft-rot bacteria in iris rhizomes. The bacteria gain entrance through wounds made by iris borers. A foul odor accompanies the decay.

*Prevention and treatment:* Plant iris rhizomes barely below the soil surface to keep them dry. Avoid crowded plantings. Prevent iris borer infestations by cleaning away all debris in the fall and spraying or dusting leaves with DDT in early spring. A spreader sticker is recommended when using such sprays on iris.

*Holmes*

Mosaic symptoms on flowers of Wedgwood iris.

*Westcott*

Cedar-apple rust, in its gelatinous spore-horn stage on red-cedar, generally induced by heavy late spring rains.

**Mosaic.** Irises are susceptible to several viruses including one which causes a mottling, or scattered green and yellow areas on the leaf. The virus is carried in rhizomes or bulbs.

*Treatment:* Remove all diseased plants and wash hands with soap and water before handling healthy plants.

**Leaf spots.** Several different leaf spots occur under certain weather conditions and may require sprays for control.

*Treatment:* Cleaning up of debris in the fall, as recommended for soft rot, is essential, since many of these organisms survive over winter on plant refuse.

### *Juniper* and *Red-cedar* (*Juniperus*)

**Rust.** Red-cedar is an alternate host for several rust fungi, including the cedar-apple rust fungus *Gymnosporangium juniperi-virginianae.* It attacks ornamental crab apple as well as trees of eating apples.

*Treatment:* If only a few trees are involved, remove the galls from red-cedar in spring. On inaccessible branches or large plantings, apply Acti-spray or ferbam to the galls just as the orange spore horns emerge from them.

**Twig blight.** Commonly observed in nursery plantings, this disease of red-cedar causes branches to turn tan and later almost white. Small black fungus fruiting bodies may appear on leaves or stems. The spores which ooze from them are spread by wind, rain, insects or pruning tools. Some junipers

are resistant (*J. excelsa* var. *stricta, J. virginiana* var. *pyramidiformis*).

*Treatment:* Prune off diseased branches, but only when plants are dry. Where the disease has been severe, spray regularly with phenylmercury, starting when new growth appears in spring.

### *Larkspur: See* Delphinium.

### *Lilac* (*Syringa vulgaris*)

**Bacterial blights.** Tender shoots may become blackened by the *Pseudomonas* bacterium. A similar blight, caused by a fungus, often kills entire sucker shoots.

*Treatment:* Bacterially diseased stems should be removed by pruning. Zineb or Bordeaux sprays, if applied early, should protect new growth when there is a fungus infection.

### *Lily* (*Lilium*)

**Root rots.** Several different fungal organisms as well as nematodes and mites have been associated with root rots. These rots generally bring about wilting, leaf yellowing, leaf scorch, or blasted buds.

*Treatment:* Plant in sterilized potting soil and avoid overwatering. Some fungicidal treatments of bulbs before planting have been moderately successful.

**Bulb rots.** Dying of basal leaves may result from bulb rots caused by *Rhizopus, Penicillium,* or *Fusarium* fungi. The first two rots are principally storage diseases.

*Prevention:* Avoid wounding bulbs. Carefully examine bulbs before planting and discard damaged ones.

**Scorch or tip burn.** While leaf tips may die because of root rots, they are similarly affected when there is insufficient calcium or nitrogen in the soil.

*Treatment:* Add lime to soil.

### *Maple, Japanese* (*Acer palmatum*)

**Wilt.** A wilting of one or more branches may indicate the presence of the wilt fungus *Verticillium albo-atrum.* Greenish-black streaks in the sapwood offer additional evidence of the disease.

*Treatment:* If only one branch is affected, pruning may save the tree. If the fungus has entered through roots, little can be done.

**Cankers.** Sunken, discolored cankers on twigs and branches of Japanese maples are caused by *Cytospora* and *Nectria* fungi.

*Treatment:* Remove diseased branches, cutting 3 to 5 inches below any discolored tissue. Adequate fertilization and water increase tree vigor, which in turn reduces losses to these canker diseases.

*Gould*

**Basal rot on narcissus bulb.**

### *Narcissus* (*Narcissus*)

**Basal rot.** Roots of narcissus rot away at the base of the bulb much as gladiolus roots do when attacked by *Fusarium,* but in narcissus the inner bulb scales become dark and spongy rather than soft and slimy. Sometimes a moldy growth can be observed on the surface. The disease is most severe in storage, but can develop late in the season and be responsible for premature browning of foliage. If diseased bulbs are planted, leaves will be small and pale.

*Treatment:* Dry the bulbs soon after digging and store in cool, well ventilated, dry places. Examine bulbs carefully before planting and use only sound ones. Avoid planting in soil known to be infested, and allow at least two or three years to elapse before replanting in the same location.

**Soft rot.** A mushy soft rot of bulbs is caused by the bread-mold fungus *Rhizopus* that also attacks sweet potato and other vegetables in storage.

*Prevention:* Do not allow bulbs to become sunburned. Avoid over-heating of stored bulbs.

**Yellow stripe.** A virus causes a mottling of leaves and sometimes a translucent streaking of flowers.

*Treatment:* Remove any diseased plants

and use insecticides to control aphids.

Narcissi are subject to other diseases, including leaf scorch, bacterial blight, mosaic, and smoulder.

## *Peony* (*Paeonia*)

**Botrytis or gray mold blight.** This fungus invades stems, leaves and buds, causing a brownish-black rot. Flowers may only partially open and turn brown. Under high humidity, affected parts are often covered with masses of spores.

*Treatment:* Remove any diseased parts promptly. Sanitation plays a significant role in control of this disease. Cutting the stems in the fall at the soil line reduces the carryover of the fungal sclerotia. Keep mulch away from sprouting stems in spring. Applications of zineb or ferbam, beginning as young stems come through the soil and continuing at 10-day intervals, are helpful.

**Anthracnose.** Curled or twisted stems with reddish lesions are caused by the fungus *Gloeosporium*. The organism also attacks leaves; buds may fail to open.

Lesions caused by anthracnose on stems of peony.

*Forsberg*

*Forsberg*

Phytophthora rot on a peperomia cutting.

*Treatment:* Spray the soil surface with Elgetol before the stems emerge in spring, and follow with several sprays of ferbam as the plants are growing.

**Bud blast.** Buds may blast because of the above mentioned diseases; however, this condition also occurs from unknown causes.

Phytophthora blight, stem rot, and root-knot nematodes are also often found on peony.

## *Peperomia* (*Peperomia*)

**Phytophthora rot.** In all stages of growth this house plant is susceptible to rot. The fungus darkens the stem, usually first at the base, causing the leaves to wilt and droop.

*Prevention:* Use cuttings from healthy plants and place in sterilized soil mixtures.

**Oedema.** Scablike swellings on the undersurface of leaves is related to overwatering in cloudy weather (*See* BEGONIA).

## *Petunia* (*Petunia*)

**Mosaic.** Perhaps the most common disease of this popular plant is the virus which causes yellowish-green areas to appear on the leaves. The plants are usually stunted.

*Treatment:* Destroy any such plants. Wash hands with soap after smoking when petunias are to be handled as this virus is commonly present in tobacco. Spray plants to control aphids which can transmit the virus to healthy plants.

**Crown gall.** Petunia is susceptible to the crown gall bacterium that produces galls on the stem near the soil line.

*Prevention:* Plant seeds in sterilized soil.

*Forsberg*

Leaf blight of phlox.

## *Phlox* (*Phlox*)

**Leaf blight.** This progressive disease, starting on the lower leaves of plants and moving up the stem, is nonparasitic. It is associated particularly with older plants.

*Treatment:* Supply adequate moisture and start new plants from cuttings.

## *Poinsettia* (*Euphorbia pulcherrima*)

**Stem and root rots.** Several different soil fungi are responsible for these important diseases of poinsettia. The early root rot that occurs on cuttings is due to *Rhizoctonia* or *Pythium*, whereas another fungus (*Thielaviopsis*) causes root and stem rot of older plants. Dark brown to black water-soaked areas appear on the stem above and below the soil line. Foliage may become yellow, with lower leaves falling. Roots may become rotten. The source and identification of the casual organism must be established to adopt the proper control measures. The *Thielaviopsis* pathogen may persist for long periods in soil on benches, in propagating beds, or dirty pots unless sanitation measures are undertaken and faithfully executed.

*Treatment:* For benches, pots, tools or gravel, use 1 part commercial formaldehyde to 18 parts water. Do not use the solution in the presence of plants. To avoid root rot on cuttings, sanitation is also important, as is good drainage in and underneath the pots.

Poinsettia cuttings are subject to the soft rot bacterium as well (*see* CYCLAMEN).

## *Rhododendron* (*Rhododendron*)

**Twig canker and dieback.** Terminal buds of rhododendron turn brown and leaves droop as in a winter condition when attacked by *Phytophthora cactorum*. Young branches turn brown from the tip down and sunken cankers appear along the stem.

*Treatment:* Prune all diseased branches well below the affected areas.

**Leaf spots.** A nonparasitic leaf spot or scorch, rather common on azalea and rhododendron, is caused by sun, wind or drought. Secondary fungi often invade this damaged tissue. Other leaf spots may be caused directly by several different fungi. Most cause distinct localized, dark-brown necrotic areas on leaves.

*Treatment:* Spraying young leaves with

*Westcott*

Weed-killer injury on rose foliage.

*Holmes*

Typical symptoms of mosaic on rose leaf.

zineb or ferbam two or three times at 10-day intervals will generally control all leaf spot diseases. To prevent the nonparasitic sort, provide proper winter protection to plants and increase soil moisture by every possible means, including winter mulches.

**Wilt.** Young plants are particularly susceptible to wilt induced by soil-borne *Phytophthora*. The organism invades roots or young stems, plugging the vessels. Initially, single branches may wilt, later the entire plant is affected. Reddish streaks in wood of the main stem give further indication of the disease.

*Treatment:* Practice rotation in seeding beds, maintain the soil pH at 4 to 4.5, and provide proper drainage. Avoid unnecessary injury when transplanting.

## *Rose* (*Rosa*)

**Blackspot.** The most serious disease of roses is named from the characteristic symptom. The edges of the black leaf spots are "feathery" and may coalesce. Diseased leaves usually turn yellow and drop, increasing the chance of winter injury. The fungus survives over winter in stems and fallen leaves. Water-films on the leaves for six hours give sufficient time for spore germination and invasion to occur. Therefore, sprays must be applied *before* rains to be effective.

*Treatment:* Folpet (Phaltan), maneb (Manzate, Dithane M-22), zineb (Dithane Z-78 or Parzate), and some copper-containing fungicides are effective materials for black-spot control. First sprays should begin early in the spring, as leaf buds open, and be continued at weekly intervals. Fungicides can be combined with compatible insecticides to reduce the work involved.

*Treatment:* Include zineb in the spray program when rust is a problem.

**Brown canker.** Several canker diseases occur on roses, but brown canker is perhaps the most serious. The reddish-bordered cankers are found mainly on stems, which they sometimes girdle. The organism also causes a leaf spot. The disease is associated with wounds.

*Treatment:* Remove and destroy all stems with cankers. Sprays used for other diseases will generally control the leaf-spot phase.

Roses are susceptible to many other diseases, including mosaic, crown gall, hairy root, nematodes, leaf spots and nonparasitic diseases such as scorch, chlorosis and weed killer injury.

## *Snapdragon* (*Antirrhinum majus*)

**Anthracnose.** Stems have elongated sunken spots, and leaves have dirty-white, slightly sunken spots and become withered when affected by the anthracnose fungus. On outdoor plants, the disease appears in August and September. Later, black fruiting bodies

*Forsberg*

Anthracnose disease of snapdragon.

appear in the center of the spots.

*Prevention and treatment:* Propagate snapdragons from seed. Provide adequate ventilation and keep foliage as dry as possible. Zineb or Bordeaux sprays will aid in control.

Other diseases of snapdragon include Botrytis blight, Phyllosticta blight, powdery mildew, several wilts, and crown and stem canker.

### *Sweet-pea* (*Lathyrus odoratus*)

**Root rot.** Various soil-inhabiting fungi produce root rots of seedlings and mature plants. When young plants are attacked, the seedlings collapse. Older plants often wilt and produce few if any flowers. Stems may be rotted at or near the soil line if *Rhizoctonia* is responsible, or below ground if *Fusarium* is the attacker.

*Treatment:* In greenhouses these diseases can be controlled by using steam-sterilized soil. On outdoor plantings drenches of Terraclor can be tried on a small scale to control the Rhizoctonia disease. Soil treatments with Vapam or chloropicrin several weeks before planting should provide control in situations where the disease has been troublesome.

**Fasciation.** A mass of abnormal growth shoots near ground level is caused by the bacterium *Corynebacterium fascians.*

*Treatment:* Sterilize the soil. Treat the seed with alcohol for 1 minute, then for 20 minutes with a 1:1000 bichloride of mercury solution. Rinse and dry before planting. The disease also attacks carnation, chrysanthemum, geranium and petunia.

Bacterial streak, several viruses, powdery mildew, anthracnose, and a fungal leaf spot also attack sweet-pea.

### *Tulip* (*Tulipa*)

**Breaking.** Flowers become variegated and leaves striped when affected with this oldest known virus disease of plants. Aphids transmit the virus.

*Treatment:* Remove all diseased plants. Control aphids with insecticides such as nicotine sulfate or malathion. The virus affects lilies as well.

**Basal rot:** *See* NARCISSUS.

**Gray bulb rot.** When plants fail to come up, bulbs may be affected with gray bulb rot caused by a species of *Rhizoctonia.* If leaves emerge they may be killed at the soil surface. Roots of decayed bulbs may appear healthy whereas the bulb scales become gray or reddish-gray.

*Prevention and treatment:* Select clean bulbs, and dip or dust them with Terraclor before planting. Do not plant in areas of poor drainage; reduce excessive applications of nitrogen, and avoid rough handling to lessen bulb rots.

### *Zinnia* (*Zinnia*)

**Alternaria blight.** Reddish-brown spots on zinnia leaves are the result of the fungus *Alternaria zinniae.* Blossoms are also affected, becoming dry and brown. Stems may have sunken cankers that cause the plant to wilt.

*Prevention and treatment:* Use treated seed and avoid planting in the same location year after year. Seedlings can be protected with fungicide sprays of maneb or zineb.

## PESTICIDES

(*Continued from page* 41)

considerable thinning may occur. In areas where the European apple sawfly is prevalent (southeastern New York and northern New Jersey) add lindane (2 teaspoons), emulsifiable concentrate, to the petal-fall spray on apples and pears. For timing and number of applications follow spray schedules for fruits available from your local County Agricultural Extension Service or in books on pest control.

Most vegetables require only specific spray materials timed for definite pests. Tomatoes and the vine crops (cucumbers, squash, melons, etc.), however, will benefit from a regular spray program with a general-purpose spray applied at weekly or two-week intervals throughout the growing season. Methoxychlor may be substituted for Sevin in the above formulation when the vine crops are in bloom to avoid killing the bees that are necessary for pollinating the female flowers. Maneb wettable powder (2 tablespoons) should replace folpet in the mixture until powdery mildew shows up. Where mites are not a problem, Kelthane can be left out of the formulation. ✦

# NEMATODES

*Soil harbors minute worms that invade plant tissues*

J. T. Walker

TRANSPARENT microscopic worms known as nematodes are present in most soils, where, in spite of improvement in control measures during the last decade, some continue to threaten the health of our plants. There are thousands of nematode species, but fortunately only about three dozen are likely to be troublesome plant pests.

Moving about in the water films of the soil, invisible to the unaided eye, the plant-feeding nematodes obtain their nourishment by puncturing plant cells with their hollow needle-like spears, called *stylets*. Many nematodes actually penetrate and reproduce in plant roots; others feed only from the outside. A few nematode species feed above ground on leaves and stems.

A single gram (approximately 1/28 of an ounce) of young strawberry roots may harbor 3,500 nematodes at the height of the growing season. An infested root system of a peppermint plant may contain 100,000 nematodes.

The sexes in nematodes are generally separate, although fertilization by the male may not always be essential to reproduction. The perpetuation of the species is accomplished by the egg-laying female, and the number of eggs produced varies with different species. Females of the cyst nematodes (*Heterodera*) and root-knot nematodes (*Meloidogyne*) may lay 500 eggs apiece. After the eggs hatch the young nematodes (larvae) moult several times before becoming adults. When moulting occurs, the entire "outer skin," which is continuous within certain body cavities, is shed. These immature larvae may resemble adults except for their small size and absence of sex organs. The life cycle from egg to adult varies with the species, the host plant and the environment, but generally takes from 15 to 38 days.

Root-knot nematodes cause swellings on the roots of many ornamental plants, including the buglewood (*Ajuga*) pictured here.

Nematodes that feed on plants above ground are found in stems and leaves, also in flower and leaf buds. The tissue they inhabit becomes scarred, stunted or distorted by their feeding activities. For example, the common leaf nematode of chrysanthemum causes the leaf tissue between the veins to turn brown and the leaf becomes distorted. The effects on the physiology and well-being of the plant by destruction of such vital organs as leaves and roots is obvious.

The economic losses to our agronomic and ornamental plants by plant-feeding nematodes is difficult to ascertain. Most estimates are based on losses in yield: *i.e.,* the yield of crops from untreated soils compared with that from chemically treated soils. In high-value crops the annual loss may amount to 10 per cent or more.

How does the home gardener determine whether his plants are being damaged by nematodes? Symptoms are not always clear-cut. Seldom do nematodes kill plants, but rather, they cause a general decline in vigor. By the time disease symptoms are observed, other organisms may be so abundant that nema-

**Leaf-feeding nematodes may make brown V-shaped areas on chrysanthemum leaves, causing them to become misshapen.**

todes are not suspected as the cause. However, if one carefully examines roots at the first sign of any abnormality or poor growth, certain symptoms characteristic of nematode attack can be observed. For example, the well-known root-knot nematode causes galls or swellings on the roots of more than 1,700 different kinds of plants. Other nematode species are more subtle in their activities, causing merely brownish root lesions not unlike those made by soil-inhabiting fungi or bacteria. Still other nematodes cause a distorted stubby root system.

The mere association of plant-feeding nematodes in the soil about diseased plants is not always proof that nematodes are the primary cause of disease, but their presence, even in small numbers, makes them suspect. Identification of the causal agent often requires further consultation with and examination by a nematologist, entomologist or plant pathologist.

Once nematodes are identified as the cause of poor plant vigor, then those concerned with growing healthy plants, including the home gardener, can undertake control measures. Crop rotation and treatment with heat or chemicals are among the methods to be used.

Crop rotation, often without being recognized as such, is one of the most effective means of controlling plant-feeding nematodes. More information is available for agricultural crops than for ornamentals. For instance, when potato cyst nematodes are a problem, sometimes a 4- or 5-year rotation of other crops is required before the nematode population is reduced to the point where potatoes can be planted again. Nevertheless, rotating annuals and perennials, or planting in different locations, are good horticultural practices that may lend themselves to control of certain nematode species.

There has been considerable popular interest in the use of trap crops, such as *Crotalaria spectabilis,* where nematodes invade the roots but fail to develop or reproduce. Similarly, root secretions from certain plants may actually depress the populations of certain nematodes. For example, storage roots of 'Mary Washington' asparagus produce chemicals which, when released into the soil about the roots, are detrimental to certain nematode species. Marigolds are also known to be unfavorable to some nematodes, and recent research has demonstrated that South American marigolds are most promising nematode "reducers" when used as cover crops.

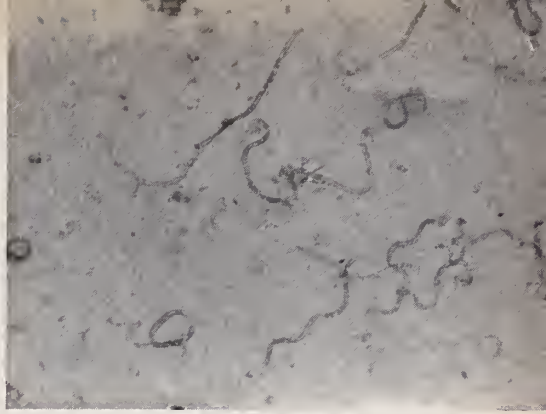
To date the most widely employed method for nematode control on ornamental plants has been heat. Immersing affected plant parts in hot water has proved particularly useful to commercial growers in the treatment of bulbs and corms, also the roots of certain plants—chrysanthemums and strawberries among them. It must be emphasized that the temperature of the hot-water baths (generally 109 - 110°F) must be accurately controlled to avoid killing the living plant. Since each plant species or variety may vary in its sensitivity to hot water, the exposure time must be carefully determined before treating large numbers of plants. In many situations, it is recommended that the plant be treated only in its dormant state.

Soil sterilization by steam or dry heat rids the soil of noxious weed seeds, insects, and disease-causing organisms, including nematodes. Many devices and machines for sterilizing large quantities of soil have been developed commercially. Home-owners can sterilize small amounts

of potting soil by placing soil in ovens set at 350°F. for one hour.

The use of chemical compounds for nematode control is not new, but the synthesis and development of such materials has progressed rapidly since the mid-1940's. Formaldehyde and chloropicrin used to be the only soil fumigants available for control of insects, weeds, and other soil pathogens, including nematodes, but the chemical industry has now synthesized a variety of effective soil fumigants. Many of these, including ethylene dibromide, D-D (dichloropropene mixture), methyl bromide, sodium methyl-dithiocarbamate, and 1,3-dichloropropene can be utilized. Most are toxic to living plants, and must be used only as pre-plant soil treatments. In the application of these fumigants, the top 8 - 12 inches of soil must be prepared to a seed-bed condition and be void of all plant residue. In addition, for these chemicals to effectively diffuse through soil, the soil temperature must be 50 to 75 degrees Fahrenheit. It is important that the soil be relatively moist, but not wet. After treatment, the soil should be left undisturbed for 10 to 14 days. In some cases, a plastic cover or water seal is employed to confine the gas in the soil. Before planting, the soil should be worked to promote aeration, taking care to avoid contaminating treated with untreated soil. Details for chemical soil treatment are provided in U.S.D.A. Agricultural Handbook No. 286 (Cat. No. A 1-9: 2048/5), available from the Superintendent of Documents, Washington, D.C. for 10 cents.

There are several commercial chemical preparations available for use on living plants, either as a soil drench or as rootdips. Unfortunately, these can not be used on all plants, nor are they effective against all plant parasitic nematodes. DBCP (Nemagon or Fumazone) and dichlorophenyl 0, 0-diethyl phosphorothioate (VC-13) have been effective against root-knot, stunt, and lesion nematodes when used as a soil drench. Although complete nematode eradication is seldom achieved with these materials, the populations are so reduced that a profitable crop or healthy plant can be expected.



These nematodes were recovered from chrysanthemum by keeping leaves in a saucer of water for several days. Nematodes can be seen by examining water against a dark background or with transmitted light.

Other chemicals which have shown some promise as soil drenches or root dips in commercial nurseries include Nellite, Bayer 25141, and Zinophos. Zinophos has proved useful in control of root-knot, burrowing, and lesion nematodes on certain ornamentals (sansevieria, gardenia, philodendron, aglaonema, boxwood). A 30-minute dip of bare-rooted plants has usually been sufficient for root-knot control. Unfortunately, this material as well as some phosphate insecticides has high mammalian toxicity, and must therefore be handled with extreme care.

Research in the use of systemic pesticides for control of nematodes is under way. Recent investigations have revealed that dimethoate (Cygon), a systemic insecticide, may have some potential in preventing root-knot nematode of tomato when sprayed on the foliage before nematode attack. But much more basic information is required before these materials will become available for use as nematocides.

Chemical compounds are continually being synthesized, screened, and tested under laboratory and field conditions for their efficiency against nematodes, and undoubtedly a nematocide or other control methods will be forthcoming that will benefit ornamental horticulture as well as agriculture.

# INSECTS AND RELATED GARDEN PESTS

Cynthia Westcott

DESPITE all control measures, insects and their allies take an annual toll in the United States of four billion dollars. We average a 10 per cent loss in food crops and there is comparable damage to ornamentals around our homes. In addition to this direct loss, insects act as vectors (disseminators) of some important plant diseases and so increase losses in that field.

## Insect Classification

Insects are in the animal phylum *Arthropoda,* all of whose members have segmented bodies, bilateral symmetry (both sides of the body looking alike), jointed legs and other appendages, and an exoskeleton (protective shell) hardened with chitin. They are separated from other arthropods by the number of legs. True insects have three pairs of legs; mites have four in the adult stage; sowbugs usually have seven pairs; centipedes one pair on each of their several segments; and millipedes have two pairs on each of their numerous segments. Slugs and snails lack true legs; they are in the phylum *Mollusca,* along with oysters and other shellfish.

## Structure of an Insect

An insect body has three parts: *head,* bearing a pair of antennae (feelers), and chewing or sucking mouth parts; *thorax,* bearing the three pairs of legs; and a segmented *abdomen.* Sucking insects obtain their food by means of a beak, bearing stylets which are thrust into plant tissue. Chewing insects have prominent jaws with which they bite holes.

Insect control was formerly based on the type of insect, contact insecticides being used for aphids and other suckers, stomach poisons for caterpillars and beetles. This distinction has largely become unimportant, for some of the modern pesticides act in both ways and some contact insecticides have a long residual effect that makes it unnecessary to have the insect present when the spray is applied.

In sucking insects the egg hatches into a larva, called a nymph, that resembles the adult except for lack of wings. This is called gradual metamorphosis. Chewing insects have complete metamorphosis. The egg hatches into a caterpillar, grub, or maggot which in turn pupates into a totally unlike form, a moth, beetle or fly.

## Description of Insects and Other Animal Pests

The various groups of animal pests are briefly discussed here in alphabetical order. Special control measures for some of the more common pests are given in the chart starting on page 6.

### Ants

*Ants,* characterized by small necks and waists, usually live in colonies. They make disfiguring nests in lawns and sometimes dry out plant roots. The large black carpenter ant may damage woody trees and shrubs. Some ants distribute and nurse root aphids for their honeydew and others are attracted to the sticky secretion of peony buds. The latter do little actual injury to the bud but they may possibly spread Botrytis spores. Chlordane is still a standard control for ants but the new mirex bait, so helpful against the imported fire ant, may also be used in the home garden. It is relatively nonpoisonous.

### Aphids

*Aphids,* plant lice, are small, soft-bodied, sucking insects of many species and colors, some being covered with a whitish powder. Aphids feed on succulent new shoots, on flower buds, inside

curled leaves and on roots. They reduce plant vigor, cause various deformations, secrete honeydew in which grows the ugly black sooty-mold fungus, and act as vectors of many virus diseases. Some have two hosts, wintering as eggs on a woody plant, then moving to annual crops, where they produce many generations of living young before another egg stage occurs. Most aphids are wingless but if the population gets too thick, winged forms develop and then migrate to another plant.

Nicotine sulfate, popular for aphids a generation ago, is still available but current recommendations favor malathion, which is less toxic to human beings. Lindane is good for root aphids and woolly aphids. Dimethoate (Cygon) and endosulfan (Thiodan) are sometimes suggested but have to be used with more care. For house plants a pyrethrum "bomb" is safe, as is washing off the aphids with soap and water.

### Bees

*Bees* are highly beneficial as pollinators but the small carpenter bee may bore into stems and the leaf-cutter bee is responsible for ovals and circles cut from the margins of rose leaves and other foliage. These are used to line nests in the pitch of woody plants. There is no very practical control. Some insecticides, such as Sevin, are toxic to bees. If used to control undesirable kinds, they may also destroy valuable pollinators. They should therefore not be used on flowers that depend on bees for pollination.

### Beetles

*Beetles* are chewing insects with a horny sheath covering membranous hind wings. The larvae, usually soft, are called grubs.

The *Japanese beetle* is now established in about half of the country—Maine to South Carolina, Massachusetts to Michigan. The beetle is ½ inch long, with tufts of white hairs extending from under the wing covers. Adults appear at the end of June (in New York), reach a peak in July, and gradually disappear in

*Roche*

A typical beetle (Asiatic garden beetle).

*Roche*

Grub of an Asiatic garden beetle.

September. They feed on flowers and foliage of 275 different plants, being partial to rose, hollyhock, mallow, canna, African (but not French) marigold, and zinnia, also the foliage of Boston-ivy and Virginia-creeper. Eggs are laid in sod and the soft, dirty white grubs, usually found in a curved position, feed on grass roots, cutting them off so the grass can be rolled back like a carpet. Sevin is particularly effective against adults on flowers. Weekly treatment with methoxychlor or DDT will keep foliage protected. Lawns are grub-proofed with chlordane

*Roche*

**Rose chafer, a slender yellowish beetle which feeds on many kinds of plants.**

or dieldrin or treated with milky disease spore dust.

The *Asiatic garden beetle,* serious along the Atlantic seaboard, is chestnut brown, the same size and shape as the Japanese beetle. It works at night, feasting on plants with foliage near the ground. The grub stage injures grass roots.

*May* or *June beetles* are somewhat larger, both as adults and as grubs. In the North, grubs may work on grass roots two or three years before adults fly at night.

*Rose chafers,* tan, long-legged beetles, are common in June on rose and peony flowers. Long, slim, black or striped *blister beetles* appear in late summer on some flowers, as do *spotted cucumber beetles,* greenish yellow with 12 black spots.

Small dark *bark beetles* flourish in unthrifty trees and the two species on elm carry spores of the dreaded Dutch elm disease.

### Borers

*Borers* are larvae of moths, beetles, sawflies or bees. They work in woody or herbaceous stems, their presence often indicated by sawdust (frass) protruding through holes in the stem or trunk. Sometimes infested portions can be pruned out. Egg-laying can be prevented by spraying bark with DDT or dieldrin at the proper season.

### Bugs

*Bugs* are sucking insects that have wings folded flat over the back when at rest. The upper half of the wing may be thickened, the lower half thin and membranous. *Lace bugs* are particularly important on ornamental shrubs and are discussed in detail on pages 69-71. *Chinch bugs* are very minute black-and-white bugs that suck at the base of grass blades, causing brown patches in the lawn. The *tarnished plant bug,* a small mottled insect, turns new shoots and buds black. The *four-lined plant bug* produces, by its sucking, round depressed areas in young leaves.

### Caterpillars

*Caterpillars* are wormlike larvae of moths and butterflies. They may be smooth or hairy, may range in size from less than an inch to the repulsive 3- or 4-inch hornworms. Besides true legs they have "prolegs" toward the rear of the long soft abdomen. Many different caterpillars appear on ornamentals through the summer, eating holes in foliage and sometimes flowers. Some, *leaf rollers* or *leaf tiers,* web or tie leaves together. *Tent caterpillars* produce the unsightly nests at tree crotches and *cankerworms* are the inchworms that may defoliate oaks and other trees in spring. Most caterpillars can be controlled with DDT or lead arsenate but Sevin is safer and reasonably efficient. In some cases the bacterial insecticide, *Bacillus thuringiensis,* gives fair control. *Cutworms,* fat greasy caterpillars living in soil, can be foiled with paper collars around young plant stems.

### Flies and Midges

*Flies and midges* have only two single wings as adults (instead of the two pairs of other insects) and the larval stage is a legless maggot. Midges are

small, gnatlike flies. The narcissus bulb fly is a large, hairy black fly marked with yellow, and it comes from a large yellow maggot, one to each rotting bulb. It may be important on narcissus and also on amaryllis. The *rose midge* turns small buds black and sometimes prevents all bloom. Some midges cause galls. The *dogwood club-gall midge* is described on page 71. The *chrysanthemum gall midge* may cause conical elevations on leaves and stems.

### Leafhoppers

*Leafhoppers*, elongate, wedge-shaped, sucking insects, hold their wings in a rooflike position. They work from the underside of foliage, hopping away quickly when disturbed. The *potato leafhopper* causes a marginal burning of dahlia leaves and general stunting. DDT usually gives excellent control of leafhoppers but Sevin or malathion may be substituted.

### Leaf Miners

*Leaf miners* feed between the two leaf surfaces. They may be the larvae of flies, moths, sawflies or beetles, and their presence is told by blotches, blisters or serpentine tunnels in foliage. See pages 86-89 for more on boxwood leaf miner, which is an orange maggot inside blistered leaves. The *birch leaf miner,* larva of a black sawfly, causes large brown blotches on foliage, making the whole tree appear blighted. There are two *holly leaf miners,* that make blotch and serpentine mines in foliage. The adults are small black flies. White serpentine tunnels of the *columbine leaf miner* are extremely common. See pages 87-89 for systemic treatment of leaf miners.

### Mealybugs

*Mealybugs* are small sucking insects often clustered at leaf-axils. They have flat, oval bodies covered with a white, powdery wax extending in short projections around the body. Some species have pencil-like filaments at the tail. Eggs are produced in white cottony sacs. Many house and greenhouse plants are subject

*Roche*

Tunnels made in columbine leaves by the columbine leaf miner.

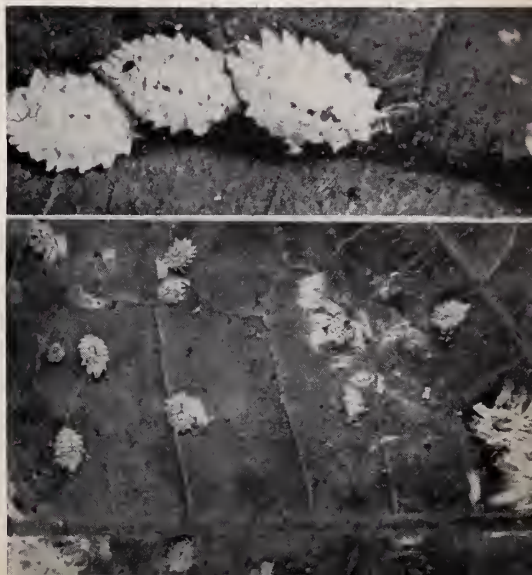
to mealybug infestations. The *taxus mealybug* is an outdoor pest on yew. Cygon is effective but must be used with caution; it injures some plants, and is less safe for the operator.

### Millipedes

*Millipedes,* sometimes erroneously called wireworms, are scavengers, feed-

Powdery white mealybugs, which are common on house plants. Upper photo shows them six times normal size.

*Buhle*



*McWhorter*

**Dusty-looking webs made between leaf-stalks and stem by two-spotted spider mites.**

*McWhorter*

**Two-spotted spider mites, greatly enlarged. Individual insect is barely visible to the naked eye.**

ing on decaying plants, sometimes injuring healthy seedlings. They are hard, wiry, cylindrical worms, grayish or brown, with two pairs of hairlike legs on each segment. They are usually found coiled up like a watch spring. DDT dusted on the soil should control millipedes on seedlings.

### Mites

*Mites* are related to spiders. They are minute in size and have four pairs of legs. They have increased in our gardens since the use of DDT, Sevin and other broad-spectrum insecticides which have killed beneficial insects that have kept mites in check. *Spider mites* (red spiders) are about as big as specks of paprika and may be green or yellow more often than red. There are several species, with the two-spotted mite prevalent in most gardens. It turns phlox leaves yellow, rose foliage reddish, yellow, gray or burned brown. There are usually cobwebs on the underside of leaves, with black dots of excrement. The *spruce mite* turns evergreens a dusty brown or gray or yellow. Safe miticides for ornamentals are Kelthane, Tedion and Aramite. Cygon may be used as a systemic.

The *cyclamen mite* is too small to see with the naked eye and does not make webs. It may injure many plants but is common on delphinium outdoors and African-violet indoors. Plants are stunted, leaves thick and deformed, flower buds turn black. Kelthane is safe to use. Endrin is effective but too poisonous for amateurs to use.

### Sawflies

*Sawflies* are related to bees and wasps. Adults resemble house flies but have two pairs of wings. Larvae may be soft and slug-like or like a caterpillar, but with extra prolegs. The rose-slug, a small, tadpole-shaped, velvety green worm, is a sawfly larva. It skeletonizes leaves, eating out everything but veins and epidermis.

There are several sawflies that feed on ornamental pines. The *European pine sawfly* hatches in late April from eggs

laid on needles. The larvae, green with shiny dark heads, work in gangs on the branches, chewing off all old needles but not the new. The *red-headed pine sawfly,* yellow with black dots, works through the summer. Sevin, DDT or lead arsenate may be used for control.

### Scale Insects

*Scale insects* comprise a very large group of sucking insects. The females are wingless and after a brief crawling stage stick in their beaks and settle down in one spot for life. Armored scales have a hard covering made of molted skins and special secretions; soft scales lack this protection. *Euonymus, oystershell, Japanese wax* and *tuliptree scales* are described and pictured on pages 67-68. The *juniper scale* is small, round, dirty white and makes its host look generally dingy and unthrifty. Lime sulfur is an excellent dormant spray for this insect, and also for the larger pine-needle scale, but it should not be used near painted surfaces. Malathion can be used for crawlers.

*Tea scale* is prevalent on camellias and Chinese holly in the South and may occur in northern greenhouses. The upper leaf surface is yellowed in mottled areas. The underside bears small brown boat-shaped females and white males in a tangle of white cottony threads. Cygon is recommended for camellias but is very injurious to Chinese holly, on which a white oil should be substituted.

*Florida red scale,* small, round, dark brownish-red; *oleander scale,* circular, flat, pale yellow; *brown soft scale,* oval flat, yellow-green to brown; and other

*Buhle*

Sowbugs, about natural size, found chiefly in damp places.

*Roche*

Spittlebugs live inside the froth that they whip up as soon as they start sucking plant sap.

southern scales are often found on indoor plants in the North. Remove and destroy infested leaves as soon as possible; keep plants washed off regularly; spray with malathion if necessary.

### Snails and Slugs

*Snails* and *slugs* are soft-bodied mollusks that leave a slimy trail behind them as they inch their way around the garden, eating large holes in leaves of violet, hosta, hollyhock and other plants that grow close to the ground. Snails, of course, have a hard shell; slugs do not. Cleaning up hiding places helps in eradicating these pests. Metaldehyde bait is standard control with Zectran a recent recommendation.

### Sowbugs

*Sowbugs* are small animals resembling miniature armadillos. They are gray, oval, up to ½ inch long, with segmented bodies and seven pairs of legs. One species, the pillbug, rolls into a ball when disturbed. Like millipedes, sowbugs are mostly scavengers, working on

bulbs or roots already decaying from other causes but they may occasionally attack healthy roots or stems near the ground. Dusting with DDT is helpful.

### Spittlebugs

*Spittlebugs*, sometimes called froghoppers, are related to leaf hoppers. They live, as nymphs, in a frothy mass that looks like beaten white of egg. Current recommendations include lindane, methoxychlor, Cygon or Zectran for control.

### Thrips

*Thrips*, very small, slender insects, have rasping mouth parts that scrape plant tissue and then suck the sap. They have wings like bristles. The *gladiolus thrips* works chiefly on gladiolus, sometimes on iris and lilies. Foliage is flecked with silvery streaks and may turn brown; flowers are deformed, spotted or streaked; many spikes fail to open; corms are sticky, corky and russeted. The thrips are yellow when young, black when adult. Dust or spray with DDT, Sevin, or lindane.

*Flower thrips* move over from flowers of weeds, grasses and trees to roses, peonies and other flowers. Petals are brown at the edges, or buds may blast and not open. Because they come every day, flower thrips are very hard to control. Cygon is suggested; DDT or malathion may help.

The *privet thrips* makes privet hedges look as if covered with dust. Spray with malathion or diazinon.

*Westcott*

Giant hornet strips bark from lilac branches to use in making paper for its nest.

### Wasps and Hornets

*Wasps* are largely beneficial; they pollinate fruit trees and parasitize harmful insects. But there are two very large wasps that may menace gardens. The *digger wasp*, also called cicada-killer, is 1½ inches long, black, banded with yellow, and has a wicked "stinger" or ovipositor at the rear. In late summer it can make a mess of lawns and even sidewalks, tunneling underground and marking the opening to each burrow with a mound of earth. The female wasp goes hunting for a cicada, drags it into her burrow, lays an egg in it, seals off the cell, and repeats the performance. The larvae hatch shortly, feed on the cicadas for a couple of weeks, then rest in a cocoon until the next summer, when they emerge to scare people with their zooming habits. Dust DDT, chlordane, Sevin or DDT in the holes. Work in the evening when the wasp is at home.

The *giant hornet* (Vespa hornet) is a little shorter than the digger wasp but stouter and hairier. It is dark reddish brown with yellow markings. It appears in mid- to late summer and tears the bark off lilac trunks and branches in irregular rings an inch or more wide. The shrub dies back to the girdled area. Many other shrubs may be afflicted but lilac is a favorite. The bark shreds are used to make nests under the eaves of buildings or in hollow trees. Spray bark with DDT or dieldrin.

### Webworms

*Webworms* are caterpillars that web branches or leaves together. The *fall webworm*, which first appears in June, is a hairy caterpillar that makes a nest

*Buhle, Westcott*

**Whitefly, a troublesome pest not easy to control. *Left:* On tomato leaf; *right:* whitefly nymphs on underside of gardenia leaf, sooty mold on upper side.**

somewhat like that of a tent caterpillar but over the ends of branches instead of back at the crotch. Usually it is easier to cut off the webbed tips than to spray the whole tree.

*Pine webworms* sew needles together in June. *Mimosa webworms* are serious in summer on mimosa and honey-locust. Sevin and malathion are safe sprays, applied mid-June and mid-August. Boxwood and pyracantha are sometimes webbed. *Sod webworms* live in silk-lined tunnels just below the soil line and chew on grass blades. Chlordane, diazinon, or DDT may be used against them.

### Weevils

*Weevils* are beetles with the head prolonged into a snout and usually with wing covers fastened down so they cannot fly. Most weevils live in the soil during the day, coming out at night to feed by notching leaves at the margin. See page 71 for a discussion of the relatively recent *Japanese weevil* now injurious to privet and other ornamentals, and the *black vine* (taxus) weevil. The *imported long-horned weevil*, small, grayish, with long antennae, feeds on many flowering and foliage plants and even gets into houses.

The *white-pine weevil* causes death of the terminal shoot, the injury being quite conspicuous as you drive through the countryside. Cut out the infested shoot as soon as noticed, well below where the yellow grubs are working, and tie a lateral branch up to a pole to make a new leader. Spray with DDT or lindane as the buds swell.

### Whiteflies

*Whiteflies*, very small sucking insects, fly out in clouds from the underside of leaves when they are disturbed. The adults have two pairs of wings, covered with a white waxy powder. Nymphs look like very flat oval scales. Whiteflies secrete a profuse amount of honeydew in which there is usually a luxuriant growth of velvety-black sooty mold. Malathion or Cygon may be used for control. ✦

# PESTS OF ORNAMENTAL PLANTS IN HOME GARDENS

*Understanding their life cycles aids in controlling them*

**Floyd F. Smith and George V. Johnson**

THE serious gardener will wish to own a complete reference manual on garden insects and their control. Such a manual is *The Gardener's Bug Book,* in which more than 1,800 garden pests and their control are discussed. Others may find sufficient information to meet their needs in certain State and Federal publications (see page 105). In the following pages we have provided information about the biology, habits and control of several damaging pests of the garden with which the home gardener, especially in the Eastern States, should become familiar. Some of these pests are widely distributed and have been recognized for a long time; others are recent invaders from other regions of this country or from abroad.

*Roche*

**Bagworms: their characteristic nests, about natural size.**

## Bagworms

The common bagworm [*Thyridopteryx ephemeraeformis* (Haworth)] frequently defoliates arborvitae, juniper, spruce, hemlock, and other evergreens. The larvae also attack many deciduous shrubs and trees. They hatch in May or June from overwintering eggs and start feeding immediately, but you may not discover their presence until July or August, when the black larvae with yellowish heads have nearly completed feeding and growth. They are hard to spot because each larva lives within a tough silken bag which it constructs and covers with needles or bits of fresh leaves from its host plant. As the larva grows it increases the size of the bag; thus the bag covering blends into the plant foliage on which the larva feeds until only bare stems remain.

The caterpillars pupate in late summer. The female never leaves the bag. After she mates with a visiting male she lays 500 to 1000 eggs, then dies. The eggs overwinter in the bag and hatch in the spring. The presence of only a few overwintering bags but each containing hundreds of eggs can cause a serious outbreak of bagworms the following summer.

To control this pest pick off the overwintering bags and destroy them. But in doing so sever with a sharp knife the encircling loop of tough silk by which the bag is attached to the twig. Otherwise the twig will be girdled as it grows during the next year or two.

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This article has been prepared in cooperation with professional colleagues at Cornell Univ.

Malathion sprays applied in June are effective against young bagworms but not against older ones. Sprays of Zectran* will effectively control the older larvae as well as the young ones. Therefore, use Zectran® instead of malathion against infestations discovered late in the season.

*U.S.D.A.*

**Oystershell scale on young birch tree, with bark cut away to show injured areas in sapwood.**

## Scales

Many species of scale insects appear on ornamental shrubs and other plants in the garden. Scales with a protective shell, separate from the body, are called armored scales and include the oystershell, euonymus, and San Jose species. Those for which the protective covering forms a part of the body wall are called soft or tortoise scales and include the wax, magnolia, and tulip-tree species. These insects insert their mouthparts through the bark and suck the sap. Severe infestations will kill branches or entire trees.

*4-dimethylamino-3,5-xylyl methylcarbamate

The oystershell scale [*Lepidosaphes ulmi* (Linnaeus)] overwinters in the egg stage under the oystershell-like covering of the female. This scale has two distinct races—the brown and the gray. Eggs of the brown race, laid on ash, boxwood, dogwood, lilac trees, and peony plants, hatch in May and mature in July when the adult female lays her eggs. These eggs become the second generation of crawlers which mature in September and in turn lay the overwintering eggs. The gray race, common on birch, lilac, maple, and willow trees, has one annual generation. Eggs of this race hatch in the spring and mature in June. The females lay eggs that do not hatch until the following spring.

The euonymus scale [*Unaspis euonymi* (Comstock)] is common on euonymus, bittersweet, and pachysandra plants. The females, 1/8 inch long, resemble those of the oystershell scale. The white needle-like males virtually cover the underleaf surface and stems. Euonymus scales overwinter as mature or partly grown females which mature in May. During the remainder of the summer two or three overlapping generations are produced. Prevalence of this scale is responsible for the decline in popularity of an otherwise useful ornamental shrub. However, modern insecticides effectively control this insect.

Because of the continuous presence of crawlers and young scales, applications of malathion sprays must be repeated at regular intervals. Summer sprays of dimethoate and winter sprays of superior (white) oil emulsions may be required for effective control.

Wax scales, including the Japanese wax scale [*Ceroplastes ceriferus* (Anderson)], are common pests in Southern States on many plants including abelia, barberry, boxwood, cotoneaster, euonymus, pyracantha, flowering quince, hibiscus, holly, spirea, and viburnum. Since severe infestations are occurring with increasing frequency in the Washington, D.C. area, and other mid-Atlantic States, wax scales may be expected to survive in the vicinity of New York City. The

U.S.D.A.

Wax scale on Burford holly, about natural size.

U.S.D.A.

Tulip-tree scale on twigs of *Magnolia soulangeana*, the shoot at left showing scales that were protected over winter by leaf mulch at ground level.

somewhat circular and reddish body of the scale is coated with pinkish white wax, has a thickened, wrinkled appearance and is about ⅓ inch across. Apparently one generation occurs annually in the Washington, D. C. area. The reddish eggs are laid in June; crawlers feed on the underleaf surfaces, and the adults are located singly or in groups, usually on the stems.

The old scales are difficult to control, but a spray of superior oil emulsion or dimethoate is effective against the young scales. Plants that may be injured by these sprays are usually listed on the container.

The tulip-tree scale [*Toumeyella liriodendri* (Gmelin)] is a common pest of *Liriodendron* but also infests Chinese magnolia (*Magnolia soulangeana*) and its cultivars. Effects of this pest become conspicuous during the summer when foliage of infested trees and the lawns underneath become stained with black sooty mold. Dead twigs are common on infested trees.

The full grown female of this insect is convex, hemispherical, and about ⅓ inch across. The females grow all summer reaching maturity in August or September when they give birth to living young. At Beltsville the young reddish-brown crawlers appear from underneath the parent about September 25, settle on the bark, and develop into overwintering dark-brown flat nymphs. Usually only a few survive the winter on exposed portions of twigs and branches, but they may be found closely packed on young shoots at the soil level, where they have been protected by fallen leaves or other mulches. Usually parasites and predators reduce this insect to small numbers, but occasionally it increases rapidly and may kill branches or entire plants.

The usual treatments for control are sprays of malathion during the early fall to kill crawlers and sprays of oil emulsions used in early spring during the dormant stage of the plant to kill overwintering nymphs. In recent experi-

ments at Beltsville, dimethoate sprays applied in the fall killed both crawlers and nymphs. Dimethoate, sprayed during the following spring and up until July 15, was also highly effective against partly grown female scales. Heretofore, no effective summer sprays were available for treatments against this scale at the time it is usually discovered by the presence of black sooty mold on foliage.

Another Japanese scale [*Pulvinaria citricola* (Kuwani)] is being found with increasing frequency in the eastern states on pyracantha, flowering quince, hibiscus and other shrubs. This scale is slightly larger than the cottony maple scale [*P. innumerabilis* (Rathvon)], but otherwise the two species are similar in their habits and in the damage they cause. In May the flat, brown females move from overwintering feeding sites on bark of larger branches to twigs and lower leaf surfaces. Each female then produces a conspicuous white cottony mass containing several hundred pearly white eggs. The shriveled body of the dead female may persist on the egg mass for several weeks. The eggs hatch within a few days, usually about June 10. During the summer the young scales feed on the undersides of the young leaves and twigs. After mating in August or September, the females move to overwintering sites on the larger branches. Only a small percentage of the scales that hatch from eggs in June survive to adulthood and overwinter to deposit eggs the next season. A thorough spraying with malathion or dimethoate applied about July 1 will destroy the young scales of this species.

## Lacebugs

The andromeda lacebug [*Stephanitis takagai* Drake and Maa (= *S. globulifera* Matsumura)], the azalea lacebug (*S. pyrioides* Scott), and the rhododendron lacebug (*S. rhododendri* Horvath) are three serious pests on Japanese andromeda (*Pieris japonica*), azalea and rhododendron, respectively.

Adults and nymphs of these species

*U.S.D.A.*

Japanese citricola scale with egg masses on pyracantha leaves.

*Connecticut Agricultural Experiment Station*

Andromeda lacebug on leaves of a species of *Pieris*.

suck out the cell contents from the host leaves as they feed on the lower surface. Their feeding injury results in grayish stippling or blanching of the upper leaf surface. Their dark molasses-like excrement mixed with the cast skins of nymphs cause unsightly spotting of the lower leaf surfaces. Severely injured plants lose their vitality and will die if infestations are not controlled.

The andromeda lacebug, probably from Japan, was first recognized in Connecticut about 20 years ago, and has spread southward. It is now established in Washington, D.C., and surrounding areas.

The azalea lacebug is an older, more widespread pest and probably occurs in all areas wherever azaleas are grown. The rhododendron lacebug is found in the northeastern United States and also in the Northwest. The three species are each about 1/8 inch long with lacy wings, but the rhododendron and azalea lacebugs have a brownish body and legs whereas the andromeda lacebug is black. Nymphs of all of these species are black, spiny creatures.

The azalea and rhododendron lacebugs attack azaleas and rhododendrons in the more sunny areas and avoid those plants growing in the shade. On the other hand, the andromeda lacebug attacks plants of

*U.S.D.A.*

Japanese weevil, greatly enlarged.

*U.S.D.A.*

Weevil injury on azalea twig compared with uninfested growth.

*Pieris* growing in both sun and shade and its injury is most serious to moderately shaded plants. First infestations often occur on branches close to the ground or in the center of the bush.

All three species overwinter as eggs which the females insert in the lower leaf surfaces. Eggs of the azalea lacebug hatch into nymphs in late April or early May in the vicinity of Washington, D.C., and become adults May 20 to June 1. The second generation in June to July and the third in August to September cause the most conspicuous damage. The rhododendron lacebug hatches later than the azalea lacebug. Adults of the second generation appear in August and lay overwintering eggs. The andromeda lacebug hatches earlier than the other lacebugs and has several more generations than the azalea lacebug. Adults of all three species are present until freezing weather in the autumn.

A single application of a spray of malathion or lindane emulsion will destroy an infestation of these lacebugs if applied in the spring after all nymphs have hatched and before they become adults and start laying eggs. A spray of dimethoate provides a longer residual ac-

U.S.D.A.

**Dogwood twig showing normal flower bud at left, club gall, and a vegetative shoot.**

tivity than malathion or lindane and is preferable for controlling established infestations later in the season.

## Weevils

The Japanese weevil [*Pseudocneorhinus bifasciatus* (Roelofs)] is a serious defoliator of ornamental plants; since its discovery near Philadelphia in 1914 it has spread northward into Connecticut and southward into Virginia. It attacks many host plants but occurs most frequently on privet, barberry, azalea, forsythia and chrysanthemum. The adults emerge from the soil in June and feed in large numbers on individual plants during the summer and fall. Damage to the plants is characteristic, consisting of rounded notches chewed in the margins of the leaves. After laying eggs late in the season, most adults die; but some hibernate in leaves and trash and emerge in the spring to lay more eggs in May and June. The larvae feed on roots of the host plant from fall to spring and emerge as adults in June.

The black vine weevil [*Brachyrhinus sulcatus* (Fabricius)] is a serious pest of European origin; it attacks about 80 kinds of plants. Adults emerge in June from pupae in the soil and feed on leaves and needles of evergreen plants from time of emergence until fall. Their feeding damage is similar to that of the Japanese weevil. In July and August they lay eggs which drop to the ground. Hatching larvae burrow into the soil, where they feed on smaller roots of host plants in the fall and girdle larger roots in the spring. Infested yew or rhododendron plants usually appear unthrifty with sparse yellowish foliage. Plants with severely damaged roots may suddenly wilt and die after growth starts in spring, especially if they were transplanted recently.

Adults of the Japanese weevil and the black vine weevil may be destroyed before they lay eggs by spraying infested plants about July 1 with chlordane or dusting with 6% chlordane dust. Dimethoate sprays are also effective.

## Dogwood Club-Gall Midge

The dogwood club-gall midge [*Mycodiplosis alternata* (Felt)] is a delicate orange-and-black fly about 1/10 inch long. In Maryland and perhaps elsewhere it emerges from late May to late July from over-wintering larvae or pupae on the soil surface. These flies deposit groups of eggs in the tip leaves of young shoots on pink and white dogwoods. Hatching maggots penetrate the stem at the base of the leaves and their feeding in the pith induces gall-like swellings. Upon reach-

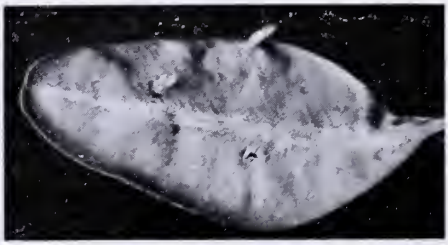
U.S.D.A.

**Galls formed by dogwood club-gall midge, the different sizes and shapes depending on the vigor of the shoot.**

ing maturity between September and November, the larvae emerge through a hole they cut to the surface and drop to the ground, where they overwinter and pupate in the spring. Usually the infested shoot beyond the gall dies and heavily infested plants become stunted. Numerous twigs may bear no flowers. Careful pruning of superfluous twigs may restore vigorous growth and flowering. Cutting out and destroying swollen twigs before larvae emerge is a practical control for the home gardener. Sprays of DDT applied weekly through June and July will control infestations in larger plantings.

### Boxwood Leaf Miner

The adult of the boxwood leaf miner [*Monarthropalpus buxi* (Laboulbène)] is a tiny yellow fly that emerges between midnight and dawn in early May from pupae in old boxwood leaves. It promptly mates, lays its eggs in the tender new leaves, and dies before the end of the day. The hatching larvae develop slowly until fall. As they feed inside the leaf from fall to spring, a cavity is formed under a blister-like swelling. In April, as they complete their growth, the orange larvae cut transparent windows in the lower leaf surface and pupate.



Boxwood leaf miner. *Above:* Pupae inside of a mined leaf (the epidermis removed). Brown head and wing pads indicate impending emergence of adults. *Below:* Pupal skins of miners projecting from underside of mined leaves after adults have emerged.

Boxwood mite injury. *Above:* Stippling and scratch-like injury on boxwood leaves. *Below:* Injured leaves enlarged.

**Damage on leaves from boxwood psyllid, with nymph shown on injured boxwood leaf at left. Normal boxwood growth at right.**

After a year within the leaf and when the pupa has developed a brown head and wing pads, it is ready to emerge. The pupa breaks through the window and soon the adult emerges, leaving the pupal case projecting from the leaf. Heavily infested plants develop sparse growth and lose their ornamental value.

To control this pest, use a spray of DDT, applied at the time the pupae develop brown heads. The spray will leave a residue that kills emerging adults before they lay their eggs in the new leaves. A spray of dimethoate applied about June 15 will destroy larvae in the young leaves. This same spray in the fall or early spring will destroy older larvae.

## Boxwood Psyllid

The adult boxwood psyllid [*Psylla buxi* (Linnaeus)], a grayish green sucking insect about 1/8 inch long, resembles a leafhopper. These insects fly from plant to plant when the foliage is disturbed. The adults deposit their eggs in July or August beneath bud scales and the tiny nymphs that hatch in October feed in place until mid-April, when they molt and move to the new leaves. Here they feed, develop rapidly, cover themselves with white waxy material, and cause a conspicuous cupping of new leaves. They molt to adults in late May or in June and cause no apparent injury to boxwood during the summer.

Sprays as applied for the boxwood leaf miner will also control this pest. If a spray is needed only for these psyllids, apply one containing lindane or dimethoate in late April to destroy the young nymphs.

## Boxwood Mite

The boxwood mite [*Eurytetranychus buxi* (Garman)] is a yellowish-green mite about 1/64 inch long that overwinters in the egg stage on the undersurfaces of the boxwood leaves. The young mites hatch in the spring and feed on the undersides of adjacent young leaves. Later, adults and larvae of succeeding generations feed on both upper and lower surfaces of the leaves, causing scratch-like markings and bronzing and decline of the foliage. After eight or more generations have been produced and the end of the growing season approaches, the adults lay their overwintering eggs.

This mite is controlled by a spray of dimethoate, as for boxwood leaf miners. Sprays of malathion or dicofol (Kelthane®) may also be used when necessary. (*For specific-purpose sprays for garden pests, please turn the page.*)

## Preparation of Sprays Mentioned on the Preceding Pages

| Insecticide and Formulation* | | Amount of purchased product per 1 gallon of water |
|---|---|---|
| malathion | 57.0% E.C. | 2 teaspoons |
| Zectran[R] | 25.0% E.C. | 2 teaspoons |
| dimethoate (Cygon[R]) | 23.4% E.C. | 2 teaspoons |
| superior oil emulsion | 100.0% E.C. | 5 level tablespoons |
| lindane | 20.0% E.C. | 1 teaspoon |
| chlordane | 40.0% W.P. | 1½ level tablespoons |
| DDT | 25.0% E.C. | 1 tablespoon |
| dicofol (Kelthane[R]) | 18.5% E.C. | 1 teaspoon |

*E.C.=emulsifiable concentrate; W.P.=wettable powder.

## Precautions

Insecticides if used improperly may cause injury to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Keep insecticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them.

When handling an insecticide, wear clean dry clothing.

Avoid repeated or prolonged contact of insecticide with your skin.

Wear protective clothing and equipment if specified on the container label. Avoid prolonged inhalation of insecticide dusts or mists.

Avoid spilling insecticide concentrate on your skin, and keep it out of your eyes, nose and mouth. If you spill any on your skin, wash it off immediately with soap and water. If you spill it on your clothing, launder the clothing before wearing it again.

After handling an insecticide, do not eat, drink, or smoke until you have washed your hands and face. Wash your hands and face and any other exposed skin immediately after applying insecticide.

Chlordane, dimethoate, lindane, and Zectran® can be absorbed directly through the skin in harmful amounts. When working with these insecticides in any form, take the same precautions as with concentrates.

DDT, dicofol (Kelthane®), and malathion can be used safely without special protective clothing or devices if they are in diluted dust or water-spray forms.

To protect water resources, fish and wildlife, do not contaminate lakes, streams, or ponds with insecticide. Do not clean spraying equipment or dump excess spray material near such water.

To protect honey bees and other pollinating insects that are necessary in the production of many crops, apply insecticide, when possible, during hours when the insects are not visiting the plants.

Avoid drift of insecticide to nearby bee yards, crops or livestock.

Dispose of empty insecticide containers at a sanitary land-fill dump, or bury them at least 18 inches deep in a level isolated place where they will not contaminate water supplies. If you have trash collection services, wrap small containers in heavy layers of newspaper and place them in the trash can. ◆

*How to recognize*

# LAWN TROUBLES

*and what control measures to take*

**Houston B. Couch**

FINE lawns require, among other factors, close attention to watering, fertilization and the height of cut. Equal attention should likewise be given to diseases which could mar the smooth green effect being sought.

Most common among living things that attack a lawn are some 200 kinds of fungi, nematodes and insects. Fortunately, not all of these cause major problems; however, the most prevalent ones, which are described here, bring about serious trouble. Methods of keeping them under control are given at the end of the article.

## Diseases Caused by Fungi

Fungi are members of the Plant Kingdom. Unlike most higher plants, however, they lack chlorophyll; therefore, since they cannot synthesize their own food, they must obtain their nutrients from organic compounds elaborated by other forms of life. Fungi that utilize dead organic matter as a source of nutrients are called *saprophytes*. Those that obtain their nutrients from living organisms are called *parasites*. While the parasitic forms are by far the most important incitants of lawn grass diseases, two saprophytic groups, the slime-molds and the fairy-ring fungi, are also known to cause diseases of turf.

### *Melting-out of Kentucky Bluegrass* (*Helminthosporium vagans*)

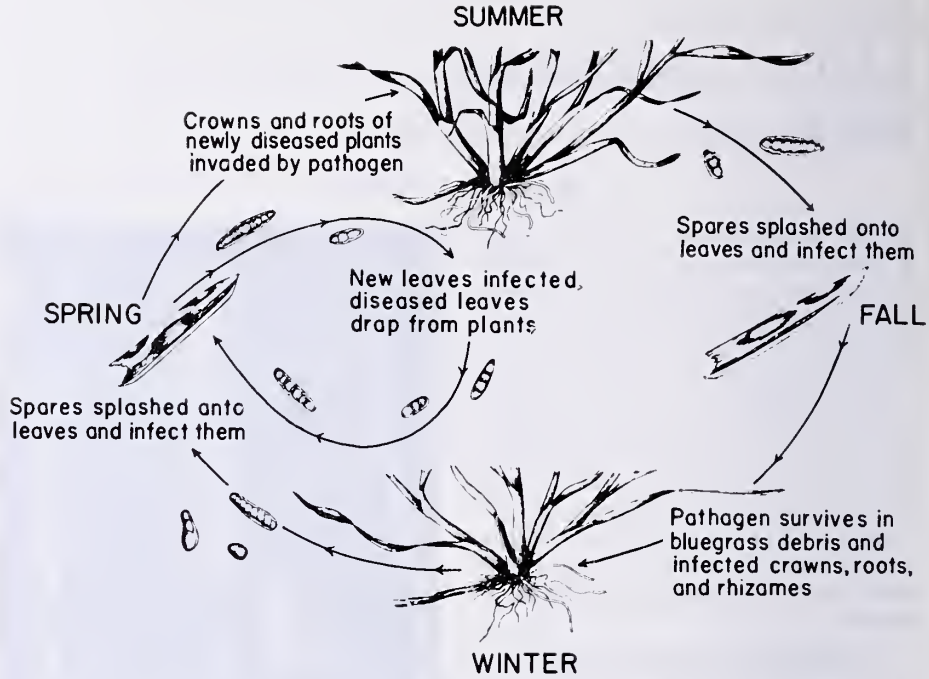
On the leaves, the fungus infection that causes melting-out first appears as small water-soaked spots which rapidly enlarge into dark purplish-red areas, the centers of which turn to brown and finally to dull white.

Although any area of the leaf may become diseased, on the sheath the infection may be so severe that it girdles the leaf, causing it to drop from the plant. This loss of leaves has given rise to the name "melting-out." During a severe outbreak, Kentucky bluegrass stands may retain only a few leaves in a square foot of turf.

Melting-out, one of several lawn troubles caused by species of the fungus *Helminthosporium*.

Along with leaf infection comes invasion and rotting of the crowns, roots and rhizomes. Plants thus infected often will wilt under soil moisture conditions that would normally seem correct for healthy plant growth.

The causal fungus survives the winter




*From "Diseases of Turfgrasses," Reinhold Publishing Corp.*

Cycle of development of melting-out disease of Kentucky bluegrass.

months in the remains of diseased Kentucky bluegrass. Spores produced in the spring are carried onto leaves by splashing water. Here they germinate and infect the new leaves, producing new spores which are, in turn, spread to new leaf parts and neighboring plants.

With the arrival of the warm, relatively dry summer months, the fungus is confined primarily to crowns and roots of plants. If cool, wet weather returns, the disease may again break out on the leaves.

### *Leaf Spot of Kentucky Bluegrass and Bentgrasses*
(*Helminthosporium sorokinianum*)

The leaf lesions of this disease are similar to those of the leaf spot phase of melting-out. They first appear in late spring as small purplish spots. As they increase in size, the centers turn brown, then fade to a light tan with purplish-brown borders. On bentgrasses, in overall view, the disease is seen as smoky-blue, irregularly shaped areas (1 to 4 feet in diameter) which rapidly develop into a water-soaked, matted-down condition.

Contrasted with the leaf girdling of melting-out of Kentucky bluegrass, this disease causes a sudden collapse and drying of the leaves. During warm, humid weather the blighting may occur within four or five days from the time of infection.

Disease severity increases with the onset of warm summer weather and decreases with the cooler fall weather. Along with the leaf spot, there is frequently a severe crown and root rot, which reduces the vigor and drought tolerance of the plants.

### *Red Leaf Spot of Bentgrass*
(*Helminthosporium erythrospilum*)

Red leaf spot is most prevalent during warm, wet weather. The circular to elongate spots are straw-colored and surrounded by reddish-brown borders. During long periods of wet weather, many of the spots may have a margin of water-

soaked tissue. Severe infection often results in a withering of the leaves, which gives a drought-injured appearance, even though soil moisture may be adequate. The disease is usually first seen in late May or early June. With the advent of warmer weather, its severity increases, reaching a peak in late July and August. At this time, particularly after long periods of wet weather, the leaf blighting and "drought-stricken" phase of the disease usually occurs.

### *Helminthosporium Blight of Fescues*
(*Helminthosporium dictyoides*)

On tall and meadow (broad-leaved) fescues, blight is first observed as short, irregular, dark-brown, transverse lines, like short strands of dark thread drawn across the leaf. Eventually these lines overlap, to make short longitudinal streaks of brown. These net-like patterns then may fuse into dark-brown solid spots. The remaining green of severely infected leaves turns yellow and the leaves die back from the tip.

On the finer-leaved red fescues the typical symptoms are small, reddish-brown, irregularly shaped blotches. Leaf girdling often occurs, with yellowing and die-back from the tip.

Helminthosporium blight is often the primary cause of summer "browning" of red fescues. At first diseased stands appear yellow, then they fade into a light brown. "Pockets" of dead turfgrass 1 to 3 feet in diameter may develop.

### *Powdery Mildew*
(*Erysiphe graminis*)

The fungus of powdery mildew is usually first noticed as isolated wefts of fine, gray-white, cobwebby growth on the upper surface of the leaves. As it becomes more dense it may cover the entire leaf. In severe outbreaks, broad sections of lawn appear dull white.

Spread of the fungus occurs by air movement. Once the fungus has reached a plant, conditions favorable for its development include: (a) reduced air circulation; (b) high atmospheric humidity, but no water on the surface of the leaves; (c) shade; and (d) an air temperature of 65 degrees Fahrenheit.

Powdery mildew on grass blades—an off-white, granular, external growth.

The pathogen survives the winter months in dead grass leaves from the previous season; it also remains dormant in infected grass plants.

Turfgrass varieties differ in their susceptibility to powdery mildew. Merion Kentucky bluegrass, for example, is more susceptible than common Kentucky bluegrass.

### *Rusts*
(*Puccinia* and *Uromyces* species)

Early infection with rust fungi appears as a light yellow flecking of the leaves. As the spots enlarge, they may become somewhat elongate. With rupture of leaf cuticle and epidermis, reddish-brown pustules develop, making severely infected plants look like rusty iron. The reddish powder that collects on fingers or shoes that are rubbed against severely diseased grass blades is composed of millions of tiny spores. These are the reproductive bodies by which the fungus is increased and spread.

As with powdery mildew, Merion Kentucky bluegrass is more susceptible than common Kentucky bluegrass to at least one rust fungus (*Puccinia graminis*).

### *Pythium Blights*
(*Pythium ultimum* and *P. aphanidermatum*)

Pythium blights, also known as grease

spot and cottony blight, are among the most devastating of lawn grass diseases. Severe outbreaks may result in complete destruction of a lawn within 24 hours from the onset of weather conducive to disease development. Renovation of the entire lawn is often necessary.

Pythium blight first appears in the lawn as irregularly shaped spots ½ inch to 4 inches in diameter. At first water-soaked in appearance, the leaves soon shrivel and the patches fade to light brown. Affected patches frequently join in streaks, the pattern being determined largely by the area's surface water drainage.

In early morning, or if high humidity is present throughout the day, diseased leaves may be covered with the white, cobwebby, mold-like growth form of the fungus.

Both species of *Pythium* may live for long periods in the soil. In lawns with a past history of pythium blight, plants infected the previous season serve as the primary infection centers. Long distance spread may occur from surface water, from infested soil carried on maintenance equipment, or by movement of diseased grass plant parts. Warm, wet weather favors the disease.

### *Fairy Rings*

Fairy rings are caused by some 48 species of soil-inhabiting fungi of both mushroom and puffball types. The mycelium of these fungi forms a dense growth of tangled threads in the root zone of the grass. This growth breaks down a portion of the soil's organic matter into ammonia. The ammonia is then reduced to a form of nitrogen that makes the grass grow faster. The characteristic symptom—concentric rings of dark green grass—then appears.

The density of the fungal growth causes the soil to become virtually waterproof, so the grass eventually dies.

The fairy-ring fungi cannot survive in the presence of the ammonia for which they are responsible, so they keep growing farther outward into uncolonized organic matter. As a result, the rings enlarge.

The most effective control of fairy ring is obtained by methyl bromide fumigation of the affected area. Directions for this treatment may be obtained from the County Agricultural Agent.

### *Rhizoctonia Brown Patch*
(*Rhizoctonia solani*)

In mid- to late summer, rhizoctonia brown patch is one of the major diseases of lawn grasses. During long-continued high temperature and high humidity, the disease can completely destroy a lawn within a short time.

Rhizoctonia brown patch occurs more often and with greater severity in turf that is cut short, where it appears as irregular light brown areas. Ranging from a few inches up to two feet in diameter, these patches are at first a purplish-green, then rapidly fade to light brown as the leaves dry out.

Where high mowing is practiced, the diseased areas range from 2 to 50 feet in diameter. These patches of light brown grass are more or less circular in outline and usually are closely appressed to the soil surface, thus creating a sunken effect.

The chief distinguishing feature of rhizoctonia brown patch is seen during periods of humid, warm weather (80 to 85 degrees Fahrenheit). At these times, dark purplish "smoke rings," ½ inch to 2 inches wide, may border the diseased areas. More pronounced in the hours of early morning, these "halos" usually fade by the middle of the day.

The causal fungus survives from year to year in a dormant condition within infected grass tissue. In the absence of susceptible grass, it is also capable of existing for long periods in the soil.

Disease severity is much greater in grass grown at abnormally high nitrogen levels. It is also increased when nitrogen, phosphorus and potassium levels are all low. Well balanced nutrition is important.

Whenever free moisture is present on leaves, the fungus spreads rapidly to healthy plants. Therefore it is wise to water the lawn in the mornings so that

the grass dries before nightfall.

Various species and varieties of turfgrass show different levels of susceptibility. In order of increasing susceptibility, they are as follows: (a) rough bluegrass; (b) Illahee fescue; (c) annual bluegrass; (d) Kentucky bluegrass; (e) perennial ryegrass; (f) Merion Kentucky bluegrass; (g) redtop; and (h) meadow fescue. While the preceding species are susceptible, the disease is not a constant threat to them. The following species are extremely susceptible to rhizoctonia brown patch and can seldom be grown without a preventive disease-control program: Seaside bentgrass (*Agrostis palustris*); velvet bentgrass (*A. canina*); and the following forms of *A. tenuis*: Astoria Colonial bentgrass; Highland Colonial bentgrass and Rhode Island Colonial bentgrass.

### *Snow Molds*

#### *Typhula Blight* (*Typhula itoana*)

The disease is usually noticed as light yellow discolored areas 1 to 2 inches in diameter after removal of snow by the first spring thaw. The leaves turn from a scalded discolored appearance to a grayish white. If conditions favor the disease, the infected spots will enlarge until they meet; then all the grass may be killed in areas encompassing several yards.

Typhula blight is distinguished by the appearance of hard fungus resting bodies called sclerotia, about the size of a pinhead, which become embedded in the leaves and crowns of diseased plants. Early in the season they are yellow or light brown; eventually they become dark brown.

The fungus survives the summer in this guise. In late fall, with the onset of cold weather, the sclerotia germinate. Optimum conditions for disease development are produced by snow falling on

Snow mold caused by *Typhula* on bentgrass. *Left:* Resting bodies (sclerotia) of *Typhula* on grass blades. *Below:* The effect of *Typhula* blight (snow mold) on a lawn.

unfrozen ground. If the snow cover is absent or disappears and the ground becomes frozen, the fungus is inactivated and disease development stops until the turf thaws. In early spring, the fungus increases its activity and the infection centers may enlarge rapidly. However, as the weather warms, fungus activity decreases.

### *Fusarium Patch* (*Fusarium nivale*)

Fusarium patch usually becomes apparent with the first spring thaw as areas of pale yellow grass, irregularly circular in outline and ranging from 2 inches to a foot or more in diameter. As numerous infection centers join under favorable conditions large areas of turf may die. It becomes whitish gray, the individual leaves having a bleached appearance and feeling slimy when wet.

Under a snow cover, or during prolonged cool wet weather, the diseased patches may be covered with a mat of aerial fungus threads. These are at first white, then turn faint pink with exposure to light. Usually only grass leaves are attacked, but the pathogen may infect crowns, causing a rot that results in complete killing of the plants.

Management practices conducive to disease development are: (a) late nitrogen applications that promote a flush of succulent growth just before winter; (b) use of straw mulch to protect turf from winter injury; (c) allowing a heavy thatch to develop; this holds moisture which gives the fungus ideal conditions for growth.

### *Fusarium Blight*
(*Fusarium roseum* and *F. tricinctum*)

When fusarium strikes, stands of turfgrass first show scattered light green patches in streaks, crescents or circles 2 to 6 inches in diameter. These rapidly become a dull reddish-brown, then fade progressively to tan, and finally to straw color. Later, the characteristic feature appears in more or less circular patches of blighted turfgrass 1 to 2 feet in diameter. They often have reddish-brown margins 1 to 2 inches wide, and contain center tufts of green, apparently healthy turfgrass. This combination produces a distinctive "frog-eye" effect.

Individual leaf spots originate both at the cut tip and at random over the entire leaf. At first they are seen as irregularly shaped, dark green blotches, which rapidly fade to a light green, assume a reddish-brown hue, and finally become dull tan.

Bentgrasses are very susceptible to fusarium blight. Ranking next in order of susceptibility are the bluegrasses and then the creeping red fescues. Development of the disease is favored by high air temperatures (80 to 90 degrees Fahrenheit) and prolonged periods of high humidity.

Both of the fungi that cause fusarium blight grow well on dead organic matter. An accumulation of thatch creates an ideal situation for the buildup of these organisms. With this reservoir of the pathogens close at hand, all that is required for a rapid buildup of the disease, and a complete loss of the lawn, is a succession of warm days and nights (80 to 90 degrees Fahrenheit) coupled with high humidity. A thatch removal program is recommended for control. While it will not completely eliminate the problem, it will aid materially in reducing the severity of fusarium blight.

### *Slime Molds*
(*Myxomycetes*)

Grass blades as well as soil surface may be covered with a creamy white, translucent, slimy growth. In a few days, yellow to gray pinhead-size reproductive bodies appear by the thousands, making the affected turf areas dull gray.

The slime molds survive adverse weather conditions as spores. With cool, humid weather, these spores absorb water, the cell walls crack open and a motile swarm spore emerges from each. These swarm spores feed on other micro-organisms and decaying organic matter and undergo various changes and fusions. Finally, they unite in pairs and form what is called a plasmodium. It is this stage that produces the slimy overgrowth on grass leaves and ground.

Fusarium patch, another type of snow mold, on a lawn.

Slime molds exclude light from leaves, thus preconditioning them to invasion and destruction by other organisms.

## Symptoms Caused by Nematodes

Nematodes are small roundworms averging 1/25 inch long as adults. They live in the soil and in the roots of many lawn grass varieties, feeding on grass roots by piercing them with a spearlike mouth part, similar to a hypodermic needle, and sucking out the contents of the cells. The small puncture wounds invite fungi which cause root decay diseases.

Nematode injury symptoms are similar to those associated with poor fertility. The plants exhibit these symptoms not because the nutrients are lacking in the soil, but because the roots have been destroyed by nematode feeding and cannot absorb the nutrients needed for proper development. If poor growth, unnatural color and thinning-out occur on turf that is receiving adequate fertilization, there is a good possibility that nematodes are involved.

For confirmation in cases where nematode injury is suspected, soil and root samples from living grass areas may be submitted to the County Agricultural Agent. Early in mid-summer is the best time, as nematode populations are likely to have reached their peak and be most readily detectable. Soil and root samples should be kept moist and cool after collection and until identification is completed.

## Insects that Cause Injury

### *Sod Webworms*

Sod webworms are the larvae of lawn moths. The adults are small whitish-gray moths which inhabit shrubbery and other sheltered areas during the daylight hours. At dusk they become active and the females scatter eggs as they fly over the grass. The worms, about ¾ inch long, are light brown and covered with fine hairs. They work only at night, feeding mostly on grass leaves, though some species feed on the grass crowns at ground level, also on roots. Their burrows or tunnels, built close to the surface of the soil, are reinforced with soil and pieces of grass and lined with a silky web.

New lawns are most susceptible to attack by sod webworms. The first signs of infestation are irregular brown spots

*Noer*

Lawn damage by grubs of the May beetle.

in the lawn. When the drying sod is broken apart, if there are three or four larvae within a section 6 inches square, an insecticide should be applied.

### *Grubs*

Larval stages of the Japanese beetle, May and June beetles, Asiatic garden beetle, Oriental beetle and European and masked chafers are among the grubs that damage lawns. They are whitish or gray with yellow-brown heads and legs and are ¾ inch to 1½ inches when full grown.

Sod turned back to show heavy infestation of May beetle grubs

*U.S.D.A.*

They hatch from eggs laid in the ground by female beetles. The larvae may remain in the soil from one to three years. During the growing season, they live 1 to 3 inches below the surface of the lawn. In the winter months, they go deeper into the soil.

Grubs feed on the grass roots about 1 inch below the surface of the soil. In overall view, the lawn assumes a scorched appearance. Affected sod may be pulled or rolled up with ease. Moles, skunks and birds feed on the grubs, and may do considerable damage to the sod when digging for them.

### *Chinch Bugs*

Chinch bugs are sucking insects. Most of their damage to grasses is done while in the nymph stage. Young chinch bug nymphs are about the size of a pinhead. They are bright red with a white band across the back. As they grow, their color changes to a yellow-red with a white body marking. Full-grown nymphs are black with a white spot on the back between the wing pads. Adult chinch

Lawn damaged by chinch bug. Dark undamaged spots are white clover; the grass is all dead. Bentgrasses are particularly vulnerable to chinch bug infestation, but bluegrass and other fine lawn grasses are also subject to damage.

bugs are about 1/5 inch long, and have black bodies with white wings.

The damage is first seen as yellowish spots on the lawn. These rapidly turn into brown, dead areas. If control measures are not practiced, the devastation can be extensive. Their life cycle is illustrated on the next page.

### *Ants*

The most conspicuous damage caused by some species of ants comes from the construction of hills around the openings of their nests. Grass roots in the vicinity of nests may be destroyed. Ants also destroy grass seeds in the ground and thus reduce the possibility of developing a thick turf.

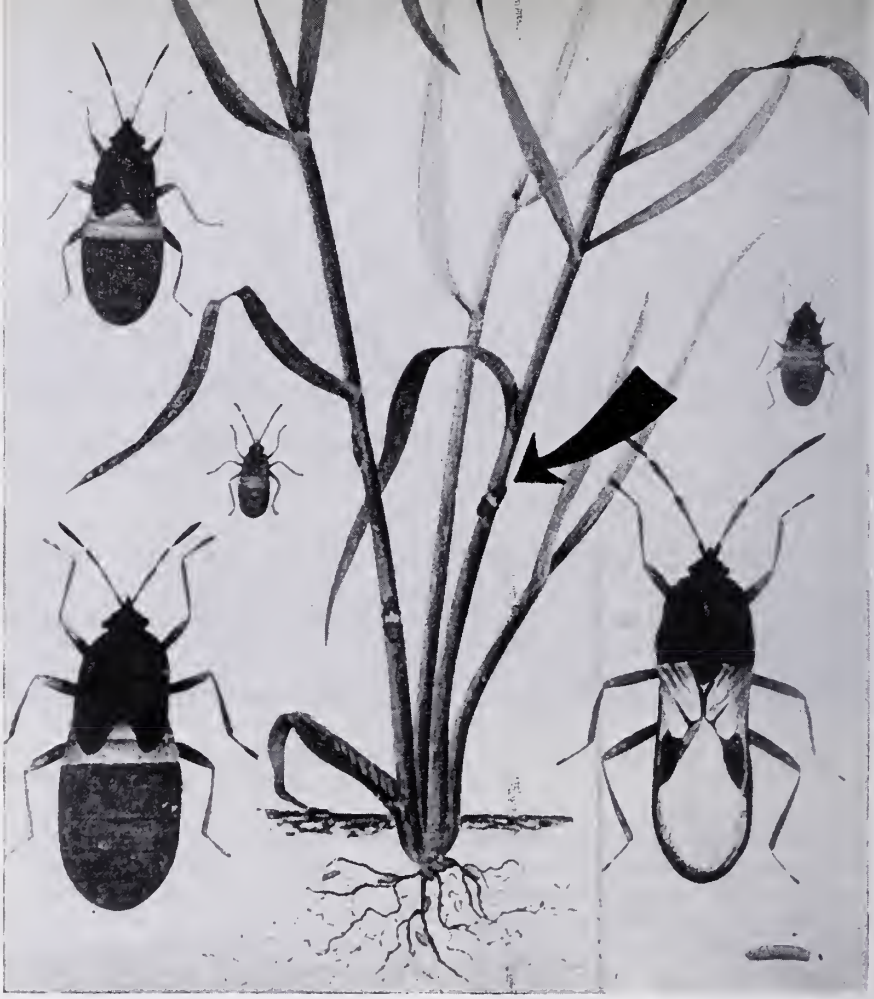
## Control of Lawn Grass Diseases

Chemicals for the control of lawn grass diseases are available as granules, dusts, wettable powders and liquids. The granules are formulated for application with the standard lawn spreader. Wettable powders and liquids may be applied with power sprayers, knapsack sprayers, or hose proportioners. Regardless of formulation or method of application, practice in obtaining uniform coverage is an important part of the disease-control program.

In the use of all pesticides, instructions on the label for proper dosage and safe handling should be read carefully. The human tendencies to add a little extra for better control or cut down on the recommended rate to save money should be curbed. The former practice could result in damaged grass and the latter in the failure of disease control. Both, then, may be a waste of time and money.

*See next page* for **Guide to the Chemical Control of Lawn Grass Troubles.**

Means of applying chemicals in liquid form to lawns. *Left:* A portable tank to hold the spray. *Center:* A hose attachment. *Right:* A motorized tank for large areas. For chemicals in powdered form, a fertilizer spreader on wheels is convenient.



*Illinois Natural History Survey*

Stages in development of chinch bug. The young are at first reddish in color, turning brownish, with white bands across back. Adults are black with white wings that extend to tip of body. Hairy chinch bug, especially damaging to eastern lawns, has short wings. Arrow points to insect feeding on grass stem.

## GUIDE FOR THE CHEMICAL CONTROL OF LAWN GRASS TROUBLES

| Diseases caused by fungi | Choice of chemicals to be used | Season and interval of application |
|---|---|---|
| Fairy rings | Methyl bromide fumigation | Consult County Agricultural Agent for procedure |
| Fusarium blight | Try Fore or Manzate D | Bluegrasses: July - August, 7 - 10 days; bentgrasses & fescues: April - September, 7 - 10 days |

| | | |
|---|---|---|
| Helminthosporium leaf spot of Kentucky bluegrass and bentgrasses | Acti-dione-Thiram, Dyrene, Daconil 2787, Fore, Manzate D, Parzate C or Tersan OM | July-August, 7-14 days |
| Melting-out of Kentucky bluegrass | Dyrene, Daconil 2787, Fore, Parzate C or Tersan OM | April-June, 7-14 days |
| Powdery mildew | Acti-dione-Thiram or Karathane | July-September, 7-14 days |
| Pythium blights | Zineb or Dexon | July-September, 7-14 days |
| Rhizoctonia brown patch | Fore, Dyrene or Tersan OM | In the North: July-August, 5-10 days; along Gulf Coast on St. Augustine grass: Early fall and spring when air temperatures are 50°-70°F. |
| Rusts | Acti-dione-Thiram or Zineb | July-August, 7-14 days |
| Slime-molds | Remove mechanically by raking or use any of the above-mentioned fungicides when disease is evident | |
| Snow molds | Dyrene, Calo-Clor or Tersan OM | Fall to spring, 2-6 weeks |

| Nematodes and insects that cause injury | Choice of chemicals to be used | Season or time and interval of application |
|---|---|---|
| Ants | Chlordane, Dieldrin or Heptachlor* | Whenever troublesome |
| Chinch bugs | Chlordane, Dieldrin, Heptachlor* or Sevin | In the North: early June, early August; in the South: V-C 13 or Diazinon on a preventive schedule every 6 weeks |
| Grubs | Aldrin, Chlordane, Dieldrin or Heptachlor* | Late April or August |
| Nematodes | Nemagon or Fumazone | 1 application when soil temperature is above 65°F. |
| Sod webworms | Aldrin, Chlordane, Dieldrin or Heptachlor* | Apply chemical late in afternoon or evening and do not water until next morning |

* Heptachlor is highly toxic; not recommended for use except by professionals.

# SYSTEMIC PESTICIDES FOR CONTROL OF INSECTS AND MITES

## *Development of chemicals to be carried in sap-stream offers promise of safety and convenience*

**John C. Schread**

THE principle of using systemic pesticides for the control of insects and mites has been known for many years. The insecticidal evaluation of phosphate, fluorine and carbamate compounds that demonstrate systemic action in plants has, perhaps, been given its greatest emphasis during the past two decades. This is because of a growing world-wide concern regarding the continuous use of poisonous sprays and dusts on vegetation.

A systemic material is one that is absorbed by plant tissue and translocated by the movement of sap from the area treated to additional parts of the plant. The development of pest-control compounds which may be used more safely through soil treatment than external application is a particularly appealing concept.

Systemic pesticides are notably effective against many species of sucking and chewing insects, in addition to plant-chewing spider mites. When absorbed by the plant, they actually become a temporary part of the plant. Then as the plant grows and functions, the systemic is distributed to foliage and other growing areas, where plant pests are killed through acquisition of a toxic meal before they injure their host. In some instances, this built-in protection may continue for weeks and months and sometimes for several years.

During the growing season, especially in spring and early summer when plants are expanding rapidly or setting fruit and seed, there is a constant succession of attacks by insects and mites. Obviously, repeated spraying or dusting is a time-consuming and often expensive chore, whereas one application of a systemic stops pest damage when protection is most needed.

Another advantage that systemics offer is protection to beneficial insects, mites and parasites—those which prey on pests of plants rather than on plants. The continuous use of many pesticides often spells disaster to these helpful creatures. Limiting the systemics to a plant's interior thereby saves many of the beneficial insect species.

Spray residue is always lost to some extent through weathering. This means the material is subject to the action of rain (or some form of irrigation or hosing), or to breakdown caused by the sun. A systemic incorporated in the plant sap-stream is well barricaded from the outside elements, therefore losses through weathering are negligible.

Pesticide residues remaining on the exterior of a plant can often be harmful to both man and animals. Therefore the use of systemics that remain inside the plant forestalls accidental poisoning and/or death of household pets, domestic and wild animals, reptiles, birds and fish, and also avoids contamination of soils and streams. Although the breakdown of a systemic in the metabolism of a plant may result in a more highly toxic compound than the parent material, it ultimately passes through a degenerating process which renders it virtually nontoxic to mammals. All of this is taking place inside the plant, thus affecting only plant-feeding insect and mite pests.

Poisoning of plants by systemics (commonly referred to as phytotoxicity) sometimes occurs. In fact, this may be expected when the recommended dosage range is exceeded or when certain types

*Connecticut Agricultural Experiment Station photographs*

Birch leaf miner. *Left:* The insect's eggs on a birch leaf. Newly hatched larvae have been killed by the systemic with which the tree was treated. *Above:* Injury on birch as compared with leaves from a tree that had been given a systemic insecticide.

of highly sensitive plants are treated. Systemics should be used only on such plants as are mentioned on the label accompanying the package.*

Stimulation of plant growth through the use of systemics is often striking. Experience with many of these compounds has shown that their use results in larger and more abundant leaves with a deeper green color. This has occurred most noticeably in birch and holly trees. A contrast of this nature, even to the uninitiated, may be convincing proof that the use of systemic pesticides is worth while, not alone from the standpoint of control of plant-feeding pests, but also for the aesthetic benefits derived.

While a number of the new systemic pesticides are now registered for use on ornamentals by the United States Department of Agriculture, not all of them are safe in the hands of home-owners. Proper equipment and protective gear for their safe handling are as essential as an understanding of the compounds and the way they work.

Systemics are available as granules, dusts, and liquid concentrates. Granules may be broadcast, used as a side-dressing, or incorporated in the soil at planting time. The dust formulations are used as seed treatments. Liquid concentrates may be injected into the soil, watered onto the surface of the ground, painted or sprayed onto the bark areas of a plant, sprayed onto the foliage, or injected into the bark.

Granules are the easiest to handle, measure and apply. One shaker container in which they are available is scaled in ounces for the correct application of a known quantity of material; the systemic thereby does not come in contact with the hands or other exposed areas of the body. Only a few of the newer systemics are labeled for general use. There are others which may be used only by specialists such as nurserymen and arborists. These will not be mentioned here.

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**Ed. note:* Applications to soil which will later produce food crops should not be undertaken by the home gardener under any circumstances.

Holly leaf miner. *Right:* Injury to holly leaves. *Left:* The pest controlled by use of a systemic insecticide.

## Techniques of Treatment

A number of methods of applying systemics to plants and row crops have been devised. For example, dimethoate (Cygon) or Di-Syston granules may be used to control birch, holly and boxwood leaf miners. For birch and holly this is accomplished by first determining the caliper (diameter) of a tree at about 3 feet above the surface of the ground. The granules, labeled 5 or 10 per cent, are then sifted onto the soil under the tree at the rate of 2 ounces of 5 per cent for each inch of caliper. This means 8 ounces of 5 per cent granules for a 4-inch tree, 12 ounces for a 6-inch tree, etc. Half as much of the 10 per cent formulation is required. The granules should be spread evenly from 1 to 2 feet from the trunk of the tree to a little beyond the outer limits of the spread of the branches. If the soil is workable, the chemical may be raked in. This does not, however, facilitate its action, nor is artificial watering necessary. Rain water will dissolve the insecticide from the granules and carry it down to the roots of the trees.

Drenching the surface of the soil is another method of applying a systemic to control leaf miners in trees, and insects and mites in low-growing plants. A systemic insecticide may be used at the rate of 1 to 2 pints in 100 gallons of water (1 to 2 teaspoons in 1 gallon). The prepared mixture is then sprinkled under the tree or other plant until all the ground is drenched. Several gallons of liquid should be adequate for treating a small tree or plant of comparable size; greater amounts will be needed for larger ones.

Injecting a systemic into the soil will provide fast absorption of the material by the root system of the treated tree or plant. A 3-foot, T-shaped injection needle with a 13/16-inch outlet diameter and two opposite ⅛-inch openings (1 inch

from its tip) may be used to make the injections. A hand shut-off valve will permit timing each injection to an average of five seconds. Soil texture may require some variations in timing. Injection holes should be made at 18-inch intervals and to a depth of 6 to 8 inches. For a large tree (6 to 8 inches in diameter per single leader or several smaller leaders totaling 8 or more inches in diameter) a number of concentric circles spaced at 18-inch intervals from the drip line of the tree toward its trunk are advisable. The insecticide may be diluted at the rate of 1 pint in 50 gallons of water and delivered from a hydraulic sprayer at a pressure of about 200 pounds at the pump. When this method of treatment is used in spring, control of leaf miners may be expected for about two years.

Painting, brushing, or spraying a systemic onto the bark of a tree (birch for example) at the rate of 4 quarts per 100 gallons (4 teaspoons per gallon) should give good control of leaf miners in small trees (1- to 1½-inch caliper), but in large ones the results may be disappointing.

Spraying the foliage of a birch tree with a systemic will control first generation leaf miners but may not, in all instances, control succeeding generations. Holly and boxwood, which have only one annual generation of leaf miners, may require a foliar spray every summer.

Bark injections have proved satisfactory. This method, however, requires special applicators which are available only to those who are trained and certified to do the work.

The lace bugs that infest andromeda,

(*Continued on page* 100)

Andromeda lace bug. *Left:* On leaves of *Pieris*. *Right:* The same lace bug greatly enlarged; normally it measures 3.5 mm. from head to wing tip.

# RESEARCH PROGRESS ON DUTCH ELM DISEASE

Craig R. Hibben

SCIENTISTS are experimenting with promising new methods for controlling Dutch elm disease. This affliction, carried to the trees by elm bark beetles, is caused by the fungus *Ceratocystis ulmi*. Standard recommendations, which include elimination of unhealthy elm wood that might be colonized by the beetles, plus spraying healthy elms with DDT or methoxychlor for protection against these pests, have been effective when carried out thoroughly. However, the disease continues to destroy alarming numbers of elm trees. Current research is therefore being directed toward easier, cheaper and more effective methods of control.

## Working from Within

Chemotherapy, or the introduction of a chemical *into* a plant to render it disease-resistant, or to kill the internal pathogen, is being evaluated as a control method. Elms have been protected from infection by introducing an organic chemical, the sodium salt of 2, 3, 6-trichlorophenyl acetic acid, into the sap-stream of the tree through holes bored into the trunk. This chemical blocks the large water-conducting vessels through which the fungus grows, thereby preventing its spread throughout the tree.

A similar compound, a mixed aminotrichlorophenyl acetic acid, retards infection by acting as a growth regulator in the sapwood. When introduced into the tree in spring, it stimulates the formation of dense, starch-filled cells which act as a barrier to the radial spread of the fungus, thereby allowing healthy wood to form outside the infected wood for the rest of the tree's growth period.

## The Beetles as a Target

Additional research efforts are aimed at more effective ways of controlling the beetles which transmit Dutch elm disease. Bidrin is an extremely toxic organic phosphate insecticide which is now being evaluated for control of the European elm bark beetle, one of two species which transmit the disease. Bidrin is forced into the sap-stream of healthy elms by special devices called Mauget injectors, that are driven into the trunk. The introduced liquid then accumulates in the small twigs upon which the beetles feed. The beetles are killed as they begin chewing the bark. Spread of the fungus spores from their mouth parts to the tree's sap-stream is thereby prevented. However, results of field tests so far indicate that Bidrin is not always uniformly distributed throughout the crowns of treated elms; therefore, further refinements and testing are required before this material can be recommended.

Bidrin is extremely poisonous to human beings, and can be fatal if inhaled or absorbed through the skin. Furthermore, accurate dosages for elms are essential because the amount of chemical required to kill the beetles approximates the amount which is injurious to the trees. Consequently, only trained operators who carry a special United States Department of Agriculture certificate are presently qualified to apply Bidrin.

It must be emphasized that the above new materials, although promising, are still essentially in the experimental stage and have not been field-tested extensively enough to supersede the standard recommendations of sanitation and spraying. Furthermore, the public should beware of the many pseudoscientific "miracle cures" for Dutch elm disease which are publicized periodically. Not one of these materials has successfully controlled or cured the disease when tested with scientific procedures.

*H. H. Lyon*

**Bark of an elm peeled back to show discoloration of sapwood resulting from infection by Dutch elm disease fungus**

## Underground Approach

Research has yielded a relatively easy, safe, and inexpensive method for preventing underground spread of the Dutch elm disease. The causal fungus can move from diseased elms to adjacent healthy elms via natural root grafts. Until recently, the only means of preventing this spread was by mechanically severing the roots between trees by trenching. Chemical root pruning of elms can now be achieved by the use of Vapam, an organic chemical normally used to control weeds, disease organisms, and insect pests in the soil. Vapam kills all roots in a narrow zone when applied to the soil between a diseased and an adjacent healthy elm. It thereby prevents root grafts and subsequent disease spread. When used correctly, Vapam kills the tree roots and grass only in the immediate vicinity of application; it does not injure the aerial parts of the healthy tree.

## Disposing of Afflicted Trees

It is fundamental in Dutch elm disease control to eliminate all weakened or diseased elms that are susceptible to colonization by elm bark beetles. It is often difficult or impossible to dispose of such trees in wooded or inaccessible areas. Experimental efforts to kill standing elms rapidly by chemical means have yielded two methods which eliminate the immediate need for cutting and disposing of undesirable trees. Either sodium arsenite (toxic to animals), or potassium iodide (relatively nontoxic to animals), when applied to cuts made around the trunk base, will quickly kill a diseased or weakened tree and render it unsuitable for subsequent beetle infestation.

## Breeding for Disease Resistance

Another approach to Dutch elm disease control which has received considerable research attention for many years has been to concentrate on the tree host rather than on the causal fungus or its insect vectors. Programs of selection for disease resistant elms and for controlled hybridization of resistant elm species have been undertaken to select or produce elms which, although susceptible to the causal fungus, can live with it with negligible effects.

Years of selection in Europe have yielded the highly resistant Christine Buisman elm (*Ulmus carpinifolia* 'Buisman') which, after testing by the United States Department of Agriculture, has been released for commercial distribution. Recently, however, evidence has accumulated that even this highly resistant elm can be killed by the Dutch elm disease, possibly through natural variations in the fungus which occur during its sexual stage.

From the Netherlands comes a recently introduced hybrid elm, the Groeneveld elm (*Ulmus hollandica* 'Groeneveld'), which is also highly resistant to the Dutch elm disease. The Groeneveld elm is now being tested for disease resistance and adaptability to different environmental conditions in this country.

Although no highly resistant American elm (*Ulmus americana*) is now available commercially, selection efforts for such a tree continue at several research institutions.

It is the aim of plant pathologists, physiologists, biochemists and geneticists to develop new control methods in time to help prevent further losses from this destructive disease. This is also the hope of those who love the incomparable American elm. ✦

# NONPARASITIC AILMENTS OF TREES AND SHRUBS IN URBAN AREAS

*Offsetting adverse conditions found in cities will improve growth of woody plants*

P. P. Pirone

TREES and shrubs in urban areas live in a far more unnatural environment than do their country cousins. The roots of trees growing along city streets are restricted by cement and asphalt pavements which greatly reduce the available supply of air and water. City soils are more compacted and have a lower content of organic matter. Nutrient deficiencies in the soil, excesses of toxic agents in both soil and atmosphere, extremely high reflected heat—these are a few of the other factors that make the growing of trees and shrubs in urban areas more difficult than in the country.

*Oxford University Press*

Leaf scorch on horse-chestnut.

## Water Deficiencies

Perhaps the most critical factor in the normal development of trees and shrubs is an adequate supply of water. A common manifestation of a deficiency of water is leaf scorch. This is extremely common on deciduous trees, especially during dry summers and in areas where the root zone is covered with impervious materials. Under these conditions the roots cannot absorb enough water to make up for that lost through the leaves by transpiration. As a result, the leaves wilt around the edges and may eventually turn completely brown and die. The severity of leaf scorch is often increased by other factors such as extensive tree wounds, girdling roots, the severing of roots while excavating for curb installation or home construction. While most species of trees are subject to leaf scorch, those most susceptible are dogwoods, maples (especially Japanese red maple), beech and horse-chestnut.

*Reducing Leaf Scorch.* Any practice that increases root development and improves the general health of the tree helps to reduce leaf scorch. The application of chemical fertilizers in early spring, especially those containing large quantities of potash, is often helpful. Insects and fungus diseases, moreover, should be kept under control. Where soils are likely to become dry, water should be applied if local ordinances permit. If the soil is heavily compacted, the surface layer should be broken up and some form of organic matter worked into it. Several inches of organic matter spread over the soil surface also helps to conserve moisture.

Leaf scorching in particularly valuable trees can be prevented, or at least reduced, by spraying the leaves with Wilt-Pruf, as directed by the manufacturer, before scorching is likely to occur.

## Water Excesses

Some trees and shrubs, especially hemlocks and yews, are harmed by excessive amounts of moisture in the soil. Where soil drainage is poor, small brown corky swellings appear on leaves and twigs. In fact, yews are so sensitive that they may die if the soil is waterlogged for 32 to 64 hours.

## Chlorosis

The leaves of some trees and shrubs turn yellowish-green, or they remain green along the veins but turn yellow between the veins as a result of a deficiency of iron. This condition is known as chlorosis or plant anemia. Sometimes it results from an unavailability rather than a deficiency of iron. In highly alkaline soils, the iron changes to an insoluble form which cannot be absorbed by the plants. For example, pin oak trees grown in soil containing limestone, coal ashes, or other alkaline materials that may raise the pH up to 7.2 or more will have chlorotic leaves and will make poor growth.

Mountain-laurel, rhododendrons, azaleas, andromeda (*Pieris*) and other ericaceous plants grown near cement or brick walls may also become chlorotic. Lime leaching from such walls increases the alkalinity of the soil near the plants' roots to a point where the iron does not dissolve in the soil solution and thus becomes unavailable to the plants.

Other plants subject to iron deficiency chlorosis include gardenia, hydrangea, and roses. Among trees and large shrubs affected are boxwood, camellia, cottonwood trees, magnolia and spruce.

Chlorosis due to iron unavailability can be corrected by increasing the acidity of the soil with either sulfur or aluminum sulfate. By acidifying the soil, the iron becomes available to the plant. Where iron is either lacking or unavailable, it can be corrected with iron chelates (pronounced kee-lates). These materials contain iron in a form that remains soluble and usable even under very alkaline conditions. One widely available brand is sold as Sequestrene 138 Fe Iron Chelate.

*Geigy Chemical Corp.*

Chlorosis in mountain-laurel leaves.

Leaf yellowing, however, can result from many other factors besides a deficiency of iron. Fungi, viruses, insect and mite infestations, low temperatures and toxic materials in the air or soil may be involved. One should consult a plant pathologist, a county agricultural agent, or some other qualified person when the diagnosis is difficult.

## Nutrient Excesses

While lack of nutrients, such as iron, will result in abnormal growth, an excess of nutrients can also harm trees or shrubs. An overdose of chemical fertilizer, for example, can severely damage trees and shrubs. Fertilizers are especially toxic when applied too close to the stems or trunks, or when the soil is rather dry. Leaching the soil with large quantities of water will reduce the damage.

## Injuries Caused by Low Temperatures

Trees and shrubs may be injured by low temperatures when in either vegeta-

*Oxford University Press*

**Frost cracks in tree trunks. *Left:* Recently formed crack at base of young horse-chestnut. *Right:* Old frost crack on flowering cherry, with callus beginning to form along edge of wound.**

tive or dormant condition. In spring a sudden drop to freezing or below will result in wilting, blackening, and death of tender twigs and leaves of deciduous trees, or reddening of the needles and defoliation of coniferous trees. Among the plants most susceptible to late spring frosts are boxwood, Japanese dogwood, pyracantha, red, white and willow oaks, hackberry, and white ash.

When a cool summer is followed by a warm, rainy autumn the growing season is prolonged. Twigs, buds and branches then fail to mature properly and hence are more subject to injury by early autumn frosts or extremely low winter temperatures. Many spring-flowering plants such as dogwood, rhododendron, azalea and magnolia fail to bloom when buds have been damaged by these circumstances.

Other factors may also cause a lack of bloom. Among them are over-fertilization, insufficient light, competition with other trees.

## Frost Cracks

On sunny days in midwinter the bark on the south or southwest side of thin-barked trees such as horse-chestnut, flowering cherry, linden, Norway and Schwedler maples is heated by the sun's rays, causing the cells to increase their respiration rate. At the same time oxygen diffuses through the lenticels (breathing pores) in the bark too slowly to prevent the accumulation of intermediate respiratory products. These products accumulate to such a point that death of the warmed bark results. Eventually the injury, known as frost crack, appears as a long open strip on the affected side of the trunk.

On newly planted trees, frost cracks can often be avoided by wrapping the trunk with burlap or specially made tree-wrap paper.

While frost cracks in themselves do not seriously impair the health of a tree, they do provide an opening for invading insects, bacteria and fungi, which impede healing and speed decay of the invaded area. Cutting the bark along the edges of the damaged area and applying a good tree paint will help speed healing and also protect the wood from these organisms.

## Winter Drying or Browning of Evergreens

Winter drying or browning on evergreens such as rhododendron, mountain-laurel, holly, pine, spruce and fir is rarely caused by excessive winter cold, but rather by excessive and rapid temperature fluctuations or late spring freezes after the plants have resumed growth.

Evergreen plants lose water by transpiration throughout the year. Although water loss is less during the winter months, it may be considerably increased when the plants are subjected to drying winds, or are grown in warm sunny spots. Unless the water loss during this period is quickly replaced by absorption through the roots, the leaves wilt, turn brown and may die.

A milder form of winter injury ap-

pears as browned areas at the leaf tips or around the leaf edges.

*Preventing Winter Drying of Evergreens.* It is more important to protect susceptible evergreens from the alternate freezing and thawing that occurs in late winter and early spring than from low winter temperatures. Heavy mulches of oak leaf-mold or acid peat-moss over the root area, by preventing deep freezing, will increase the roots' ability to absorb moisture. However, mulches used for summer retention of moisture around such plants as boxwood and azaleas should be removed from the bases of the plants in mid-August to allow the bark and wood to dry and mature before early autumn frosts occur. They should then be replaced after the first heavy freeze in late fall or early winter. Heavy snows during the winter also act as mulches and thus help to protect plants from low winter temperatures.

In new plantings it is wise to set plants on well-drained sites. There they will develop deeper and more extensive root systems which will make them better able to survive the winter.

Susceptible evergreens should be planted in spots protected from the sun and wind. Southern exposures should be avoided.

Established plantings of susceptible plants like mountain-laurel, rhododendrons and leucothoë can be protected by windbreaks of narrow-leaved evergreens which usually suffer less in unfavorable situations.

Before the soil freezes in late fall or early winter, the soil around susceptible evergreens should be soaked thoroughly. The procedure should be repeated in late winter or early spring at a time when the soil is not frozen.

Boxwood, rhododendron, mountain-laurel and other plants subject to winter browning can also be sprayed with an anti-transpirant such as Wilt-Pruf to help reduce the trouble. It the latitude of New York City, this or a similar material should be sprayed on the leaves on a mild day in early December and again on a mild day in late February or March.

*Oxford University Press*

**Winter browning of rhododendron leaves.**

## Mechanical Injuries

Damage, especially to the trunks of trees, by motor vehicles, children and even thoughtless adults is of common occurrence in heavily traveled or populated areas. Injuries to the trunk call for immediate treatment. The loose bark should be removed and the bark along the edge of the wound cut with a sharp knife in the form of a pointed ellipse (boat shaped). The cut edges should be painted with orange shellac and the exposed wood with tree paint, which is available in push-button cans.

*Girdling Roots.* Many trees are weakened and others are killed from constriction by their own roots. When roots grow closely appressed to the main trunk, they may choke the trunk and thus restrict the movement of nutrients. Some refer to this occurrence as "tree suicide." A wire left around a branch for a number of years will have the same effect.

Girdling roots most frequently develop at ground level and are then easy to detect. If they form below ground, however, they are more difficult to discover.

Girdling root at base of sugar maple. *Top:* Root obstructing flow of water and nutrients into tree. *Center:* Cutting away girdling root with wood chisel. *Bottom:* The stricture removed and the tree given a chance for survival.

They can be suspected if the trunk ascends straight up from the ground, or is slightly concave at one side instead of showing the normal flare or buttress at the soil line.

Trees growing along paved streets, particularly maples, suffer more from girdling roots than do those in open areas, and middle-aged or old trees more than younger ones.

*Changing Soil Level Around Trees.* Raising the soil level around trees is highly detrimental to their health. The addition of a deep blanket of soil beneath the tree is likely to kill the roots by preventing the normal circulation of air and moisture. Eventually, single branches or the entire tree may die. Before any change in grade is made, a competent arborist should be called to suggest precautionary measures.

*Fire Damage.* Too many home owners assume that it is safe to burn raked-up leaves under trees. Unfortunately, heat from such fires often kills the cambium layer beneath the bark. The bark itself then becomes susceptible to invasion by borers and fungi.

## Chemical Injuries

*Salt.* Rock salt (sodium chloride) and also calcium chloride applied by homeowners or building superintendents to keep ice from sidewalks, or applied by highway departments to keep vehicles from skidding, weakens and kills trees, shrubs and lawn grasses. The salty water is frequently swept into the soil area or is splashed into it by passing traffic. Rock salt is five to ten times as toxic to trees as calcium chloride.

A recent study of 550 maples growing along a highway in New Hampshire showed that decline in these trees was caused by excessive amounts of salt. Damage was limited to trees growing close to the highway or directly in the drainge area. The leaves and twigs growing within the windrow of ploughed snow had higher than normal levels of sodium. Soluble salts in maple sap were also higher than normal.

As long as salt is used, every effort should be made to keep it from reaching adjacent soil and plants. On highways, correction of drainage may be the only solution.

*Dog Urine.* Some trees die as a result of frequent visitations by male dogs. These result in so-called "dog cankers" which appear as dead, sunken bark at the tree's base. A metal collar is not enough to prevent such damage because the toxic secretions enter the soil anyway and thus kill the roots. The soil around some trees frequently visited by male dogs has been found to contain nearly 1000 parts of soluble salts per million parts of soil. This is several times the maximum tolerance for most trees. The problem is a difficult one, though there are sprays that are said to be repugnant to dogs.

*Weed Killers.* The various chemicals used to control weeds will damage or kill trees and shrubs when not used as directed. Those containing arsenicals and pentachlorophenol are especially toxic.

The hormone-type weed killers containing 2,4-D, 2,4,5-T and related compounds used to control broad-leaved weeds in lawns will also damage trees and shrubs. Several poison-ivy killers will damage or kill valuable plants growing nearby. The greatest of care is therefore required when applying weed-killing chemicals. Absence of wind and accuracy of aim are both essential.

Spray tanks used to apply 2,4-D and related materials should not be used to apply insecticides or fungicides without first being thoroughly cleaned. Rinsing with plain water will not remove the weed killer. Household ammonia, 4 ounces in 3 gallons of water, or sal soda, 4 ounces in 3 gallons of water, will remove all traces of the weed killer. Either one of these materials should be left in the sprayer for two hours, then drained through the sprayer nozzle. Finally the sprayer should be rinsed with clear water.

*Air Pollutants.* Smoke emanating from the chimneys of factories, public utilities and apartment house incinerators contains ingredients which are harmful to trees and shrubs. One of the chemicals most toxic to the leaves is sulfur dioxide, which can cause plant damage at concentrations as low as a half part in a million parts of air. There are times when the concentration in the vicinity of buildings, where sulfur-containing oil or coal is burned, gets as high as two or more parts per million. The leaves of maples and some broad-leaved trees exposed to high concentrations of sulfur dioxide show ivory-white markings, mostly between the veins. On other broad-leaved trees the markings are dark brown in color, and also mainly between the veins.

Other pollutants common in large cities are smog and ozone. Smog is a complex of liquids, solids and gases comprising more than 50 chemical elements and compounds. Ozone, which is highly toxic to vegetation, is formed by a reaction between the ultraviolet light in sunshine and the nitrogen dioxide and hydrocarbons in the atmosphere.

Soot, the solid or particulate residue of smoke, may also damage plants. This material settles slowly on the leaves and may eventually coat them completely. Here, the damage does not result from clogging of the breathing pores, as some believe, but from the screening out of sunlight. The sharp reduction in light reduces the capacity of the leaf to manufacture food, and consequently results in serious impairment of the general vigor of the plant. Because the leaves of evergreens remain attached throughout the year (in some species several years), a considerable deposit may accumulate and thus greatly reduce the chances of survival of these trees. Soot is one factor that makes it difficult to grow evergreens in large cities.

*Automobile and Bus Fumes.* Trees growing along city streets are also subject to exhaust products of automobiles and buses. For years I have observed that trees nearest bus stops or traffic lights were not as vigorous as those growing at some distance. Automobile exhaust contains carbon monoxide and ethylene, both of which are known to be toxic to leaves

(*Concluded on page* 104)

# EQUIPMENT FOR APPLICATION OF PESTICIDES

Cynthia Westcott

Apparatus for the application of liquid garden sprays ranges from small aerosol cans to large power hydraulic syrayers and mist blowers.

### Aerosol "Bomb"

The aerosol "bomb" is handy for indoor plants and for spot treatment of aphids or other pests on new shoots outdoors. It is not advised for general outdoor treatment. *Warning:* Injury may ensue if used too close to plants. Hold the can 12 to 18 inches away and operate it in short bursts. Make sure it is labeled for plants, not for household pests.

### Hand Sprayer

Small hand sprayers of the atomizer type with continuous or intermittent action are likewise limited to house plants or a few specimens in the garden. They usually hold 1 quart.

### Compressed Air Sprayer

The compressed air sprayer, of 1½- to 5-gallon capacity, will take care of most ornamentals in the garden if one is physically equal to pumping it up. It has to be shaken frequently. Most have tanks of galvanized steel, brass or copper but there is also a light-weight plastic model on the market. Many have a strap for carrying over the shoulder but some are mounted on wheels.

### Knapsack Sprayer

The knapsack sprayer, carried on the back, is a bit heavy for a woman, but pumping is effortless, merely the lifting of a lever up and down during spraying. There is an efficient agitator.

### Trombone Sprayer

The slide or trombone syrayer is liked by many gardeners because it is easily operated and durable. Material is drawn from a pail or an attached container.

### Wheelbarrow Sprayer

The wheelbarrow sprayer is a manually operated hydraulic sprayer mounted on a frame with one or two wheels. With a capacity of 12 or more gallons, it is fine for large gardens, but it takes two people to operate it efficiently.

### Hose-end Proportioner

The hose-end proportioner sprayer is easy to use where there is sufficient water pressure and a hose outlet near the garden. For shrubs use the type with extension tube and deflector so that the spray can be directed up through the foliage. Hose-end proportioners that spray out directly are mainly suitable for lawn treatment.

### Various Dusters

Dusters range from a rubber bulb or cardboard carton to power equipment. Dust guns of 1-pint to 2-quart capacity are relatively inexpensive and satisfactory for small gardens. A light-weight midget rotary duster is excellent for any size garden and is well worth the price (around $10). Be sure to order an extension tube with the duster and be sure to use the machine with the dust flowing up. Enough dust drops down to take care of upper surfaces. A bellows duster, holding up to 8 pounds, allows quick coverage of a large number of plants, as does the crank-operated knapsack duster. ✦

*Drawings by Eva Melady*

Trombone or slide sprayer, operated with both hands, draws material from a pail. Suitable for small trees.

Power sprayer for large gardens.

Midget rotary duster with an extension tube should always be used with dust flowing upward.

Compressed air sprayer has to be pumped and also frequently shaken.

← Hose-end sprayer, easy to use where there is sufficient water pressure, draws chemicals from an attached jar and dispenses them in proper dilution.

## SYSTEMICS

(*Continued from page* 89)

azalea and rhododendron are successfully controlled with systemics used as granules, soil drenches, injections or foliar sprays. From 2 to 4 ounces of 5 to 10 per cent granules spread evenly over the surface of the ground under a 3-foot plant from its base to the periphery will control the pests. Annual treatments may sometimes be needed.

Scale insects and mealybugs, for the most part, are not easily controlled with systemics applied to soil surface. Foliar or bark sprays are usually needed for satisfactory results.

Systemics are compatible with fertilizers, also with other insecticides, miticides and fungicides in common use. Under most conditions this may not be an important consideration. It should, however, be kept in mind.

The first procedure to follow in using any pesticide, systemic or otherwise, is to read the package label *carefully*. Certain precautionary information will be in-

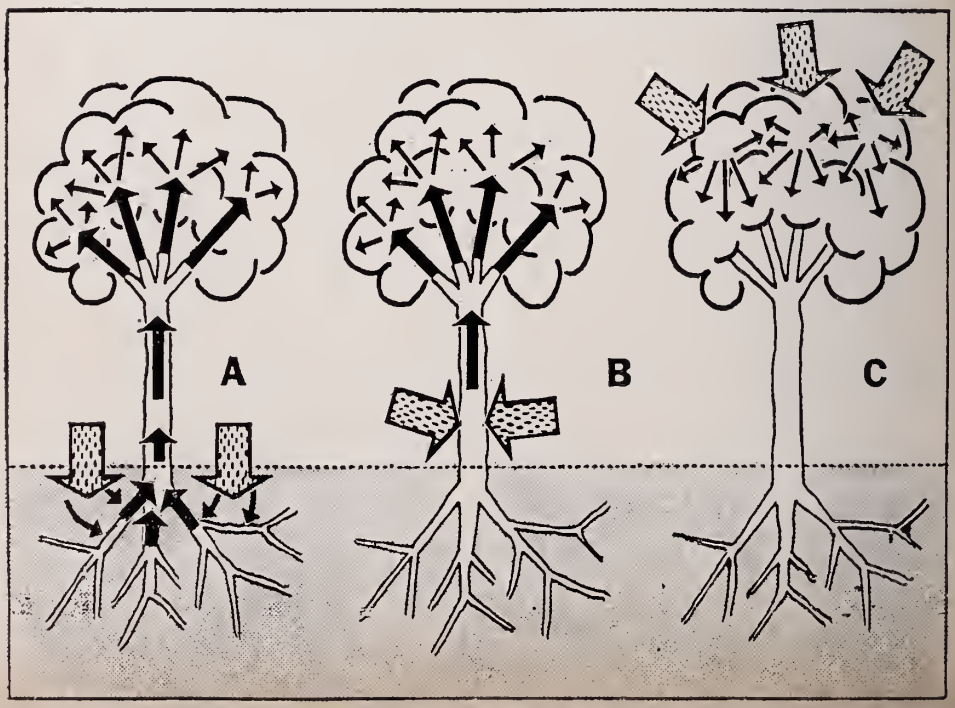
(*Concluded on page* 101)

*Courtesy Forest Experiment Station, Baarn, Holland*

'Groeneveld' elm, derived essentially from *Ulmus hollandica*, itself a hybrid. So far, this clone leads all others in combined resistance to Dutch elm disease and coral spot (*Nectria*) canker.

How systemic pesticides are applied. **A:** To the soil, from where they are absorbed through the roots. **B:** Applied to the stem or bark by painting or injection. **C:** Sprayed on the foliage. From any of these plant surfaces they are able to enter the sap stream, from which their poison is delivered to insects that attack the plant.

*Courtesy of H. T. Streu, Rutgers University*



# WHAT OF FUTURE PEST CONTROL?

## Jerry T. Walker

"WHAT a difference a day makes!" Borrowing the theme of a popular song of some years back brings to mind the rapid changes being experienced in today's pest control programs. Especially is this so in the years since the *Pest and Disease Handbook* of 1955. Most of the same plant pests remain, but for their control new materials are constantly appearing. And of course we have new pests to guard against as people and plants—as well as pests—jet from place to place.

What will the next ten years bring in the way of pest control for home gardeners? It is interesting to speculate how the gardener in the mid-70's will care for his lawn, his flowers and his shrubs and trees.

A recent business review estimated that $4½ billion is being spent annually on all goods for gardening in the United States. As population grows, it seems reasonable to expect that these expenditures may double in the next ten years. Out of this total, even the small proportion spent to keep plants healthy will still be an impressive sum. But for what will this money be used?

Among pesticides there will be safer and more selective chemicals which may require only one application to an ornamental plant or to the turf. These will provide plants with a long-continuing resistance to some of the most troublesome pests.

Biological methods of control are certain to receive increasing attention. As more is known about the natural enemies of insects, means of supplementing the natural production of predators may become standard practice. For example, the release of sterilized male insects, as is now done with screw-worm fly, Mediterranean fruit fly and others, will assist in widespread control of many threatening pests. Furthermore, manipulating reproductive capacity of insect pests with chemicals, light or vitamins may be achieved.

Current work on insect viruses provides great potential for insect control in the years to come. The use of sound and ultra-sound as well as other physical phenomena in pest control may also become significant.

Control of diseases of ornamental plants may be revolutionized further through a clearer understanding of the nature of disease resistance, the mechanism of chemical action, and the ultra-structure of the cells of hosts and parasites. The use of systemic fungicides may well become standard procedure. Hybridization and selection will not only bring better foliage, more colorful flowers, stronger stems, and more interesting character, but hopefully, greater resistance to wilts and blights.

Herbicides and other growth regulators will surely gain in use. It is likely that they will be applied to far more plants than the successful pre-emergent crabgrass killers of today.

The present Handbook includes many of the developments made in plant disease and pest control since 1955. The next edition—perhaps ten years hence—should reflect the promise of present-day research in the interest of healthier, stronger and even more beautiful plants. ✦

(*Continued from page* 100)
cluded. When it is advisable to protect the person handling the material, the types of clothing, gloves, respirator and goggles will be specified. Their use is obligatory and should be heeded on all occasions. In all applications, use only the amount recommended on the label. ✦

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## NONPARASITIC AILMENTS

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of trees and shrubs. Buses release formaldehyde and oily precipitates that also are harmful to leaves of trees.

Controlled experiments have recently revealed that automobile exhaust gases subjected to simulated sunlight (sun lamps) are toxic to the leaves of several plants. Some plants are extremely sensitive even to low concentrations of ethylene. Marigold leaves, for example, do not develop normally in the presence of five parts of ethylene in a hundred million parts of air. Leaf irregularities and poor flower formation occur in tulips and narcissi at concentrations of 400 parts per hundred million parts of air. The sepals of some orchid flowers wither and dry when exposed to 5 parts of ethylene in five billion parts of air.

Indeed, trees, shrubs and all other forms of plant life in cities have survival problems far more severe than those of plants which grow in suburban or rural areas.

# SUGGESTIONS FOR FURTHER READING

## Books and Bulletins


Couch, Houston B. *Diseases of Turfgrasses.* Reinhold Publishing Co., New York, 1962.

Forsberg, Junius L. *Disease of Ornamental Plants.* Univ. of Illinois Special Publication No. 3. Urbana, Ill., 1963.

Frear, D. E. H., editor. *Pesticide Handbook —Entoma.* College Science Publishers, State College, Pa., 18th edition, 1966.

Johnson, George V. and Floyd F. Smith. *Insects and Related Pests of House Plants.* U. S. Department of Agriculture Home and Garden Bulletin 67. U. S. Government Printing Office, Washington, D. C., 1963.

Kreitlow, K. W. and F. V. Juska. *Lawn Diseases.* U. S. Department of Agriculture, Home and Garden Bulletin 61. U. S. Government Printing Office, Washington, D. C. 1963.

Pirone, Pascal P. *Tree Maintenance.* 3rd ed. Oxford University Press, New York, 1959.

Pirone, Pascal P., Bernard O. Dodge and Harold W. Rickett. *Diseases and Pests of Ornamental Plants.* Ronald Press, New York, 1960.

Pyenson, Louis. *Keep Your Garden Healthy,* E. P. Dutton & Co., New York, 1964.

Shurtleff, Malcolm C. *How to Control Plant Diseases in Home and Garden.* Iowa State University Press, Ames, Iowa, 1962.

Smith, Floyd F. *Controlling Insects on Flowers.* U. S. Department of Agriculture Agriculture Information Bulletin 237., U. S. Government Printing Office, Washington, D. C. 1962.

*Insects.* The Yearbook of Agriculture, U. S. Department of Agriculture. 1952. Washington, D. C.

*Plant Diseases.* The Yearbook of Agriculture, 1953. Washington, D. C.

Westcott, Cynthia. *The Gardener's Bug Book.* 3rd ed. Doubleday & Company, New York, 1964.

————. *Plant Disease Handbook.* 2nd ed. D. Van Nostrand Company, Princeton, N. J., 1960.


## Circulars for Reference


*Control Turfgrass Diseases.* 1963. Pennsylvania State Univ. Agr. Ext. Service Circular 510.

*Lawn Diseases in the Midwest.* 1963. North Central Regional Extension Publication No. 12. Univ. of Nebraska College of Agriculture and U.S.D.A. Cooperating.

*Lawn Diseases—How to Control Them.* 1960. U.S.D.A. Home and Garden Bulletin No. 61.

*Lawn Insects—How to Control Them.* 1964. U.S.D.A. Home and Garden Bulletin No. 53.

Schread, John C. 1965. *Dogwood Borer.* Conn. Agr. Exp. Sta. Circ. 199 (Rev.): 1-3.

Weidhaas, John A. 1962. Cornell Recommendations for Trees and Shrubs. N. Y. State Coll. Agr. Expt. Pub.: 3-21.

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BROOKLYN BOTANIC GARDEN RECORD

# PLANTS & GARDENS

## BONSAI: SPECIAL TECHNIQUES

Bonsai Styles:

Cascade
Forest
Stone-Clasping
Miniature

Culture:

Pinching
Pruning
Wiring
Watering
Winter Care
Soils

Bonsai Nursery Areas in Japan

SUMMER
1966

NEW SERIES

Vol. 22 No. 2

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# PLANTS & GARDENS

Vol. 22 Summer (August) 1966 No. 2

## HANDBOOK ON BONSAI: SPECIAL TECHNIQUES

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Drawings by Eva Melady and Elizabeth Scholtz

Color illustrations by Hal H. Conroy

Published quarterly at 3110 Elm Avenue, Baltimore, Md. 21211, by the **Brooklyn Botanic Garden, Brooklyn, N. Y. 11225.** Second-class postage paid at Baltimore, Md., and at additional mailing offices. Subscription included in Botanic Garden membership dues. To others, $3.00 per year ($5.00 for two years). Copyright, 1966, by the Brooklyn Botanic Garden.

# JAPAN

KUNASHIRI ISLAND
HOKKAIDO
formerly EZO
(Ezo Spruce)
(White Pine)
(Zelkova)
(Juniper)
Sendai
Sendai Bay
(Hybrid Pine)
HONSHU
Omiya
(Bonsai Village)
Tokyo
Inland Sea
Mt. Fuji
SHIKOKU
Takamatsu
Kinashi Village
(Black and White Pines)
Yawata
KYUSHU
Mt. Kuju
Mt. Yufu
(Rhododendron kiusianum)

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Summer 1966

Since the publication of our first Handbook on DWARFED POTTED TREES—THE BONSAI OF JAPAN (which has now gone through ten printings), there has been an ever-increasing interest in this subject in the United States; half a century ago such dwarfed trees were scarcely known outside Japan. Today they have gained world recognition. Indeed, the word "bonsai" has become part of an international vocabulary.

This second Bonsai Handbook is devoted chiefly to describing methods for the training and culture of some of the more specialized forms of bonsai. Many of the thousands of bonsai questions asked of the Botanic Garden include "How do I create and grow a bonsai forest landscape?" "How can I train a rock-clasping bonsai?" "Are there special techniques for maintaining the truly miniature bonsai?" —and so on. Our earlier Handbook did not answer such questions, at least in any detail, so we went back to Mr. Kan Yashiroda (Guest Editor of two earlier Handbooks in the Botanic Garden series) and asked him to take on this new editorial assignment. He invited some of Japan's most talented bonsaimen to participate, and has himself translated their work into English so that we of the West might have access to it.

Three thousand students from sixteen States have taken popular-level bonsai courses here at the Botanic Garden over the past dozen or more years. Several hundred of them have gone on to our advanced courses. Many worked under Mr. Yashiroda's direction, others under the Garden's own skilled bonsaiman, Mr. Frank Okamura. Their ideas and suggestions are incorporated in short articles throughout the Handbook.

In addition to the authors, Guest Editor and members of our Editorial Committee, it is a special pleasure to acknowledge the tireless efforts of Miss Mary Barnett as Associate Editor. And for financial assistance with the publication of the color illustrations (all originals) we are deeply indebted to Mrs. Kenneth Hume of Carmel, New York, and to Mr. Jerome Lukins of Port Chester, New York.

Spawned from a knowledge of bonsai culture, the techniques of artistic size-control of trees and shrubs, and pruning for asymmetry, are meeting warm acceptance by discerning gardeners. This is a happy extension of bonsai techniques to the outdoor garden. A noted Japanese author writes that the cult of "the small" has long been a part of the Japanese cultural heritage, due in part to the demands placed upon space by the mountainous terrain of a small and heavily populated island country. Early in Japanese history, patrons of the arts did indeed begin to prize "potted trees," but for centuries these remained trees stunted by Nature, occasionally tinkered with but never guided from the start by human craft. The situation is now quite different, and the Western world is privileged to share in this cultural "export" from Japan.

May the two companion Handbooks on Bonsai (we really ought to call them BONSAI I and BONSAI II) help you on your way to greater understanding and enjoyment of this unique living art.

George S. Avery

Director

Color postcards and Kodachrome transparencies of the bonsai pictures on pages 41-48 are now available. Use the address at the top of the page and remit $1.00 for fourteen different cards; $1.75 for ten transparencies. These amounts include sales taxes and postage.

# EXPERIMENTING WITH BONSAI STYLES

## *How to train nursery stock in patterns inspired by the Japanese*

**Kan Yashiroda**

NOT long ago when some bonsai pictures were shown me by a bonsai-man I know, I asked him if he could claim these as trees that he himself had formed and trained. His answer was in the form of a protest: He said that no bonsai of note in Japan has been developed by a single man. Rather, it has belonged to many men in the course of years, and each has influenced its training in his own way.

There is much truth in what he said, though his answer had wisely escaped from my question. Bonsai training and culture in Japan are a composite art, just as wood-block printing is a composite art of the painter, engraver and printer.

In Japan many bonsai have been in training since the beginning of the century and are now on the market, most of them at moderate prices. But since a backlog of already-trained bonsai does not exist in the United States, Americans, in their traditional pioneer spirit, must start afresh with nursery stock. Eventually some of you, perhaps some who are beginners today, will create new styles based on American trees and landscapes. While Americans are still learning the art of bonsai culture, however, all the styles

*Pulitzer*

*Roche*

"Since a backlog of already-trained bonsai does not exist in the United States, Americans, in their traditional pioneer spirit, must start afresh with nursery stock." Above, bonsai in training, created from nursery trees. *Left:* false-cypress *(Chamaecyparis pisifera); right:* Japanese holly *(Ilex crenata helleri).*

*Roche*

"Cotoneasters have already been so widely adapted as bonsai that a new style based on them seems to be developing." Nursery-grown cotoneaster before and after it was pruned and wired for training by Frank Okamura. Foliage masses will now develop around remaining branches.

which have been developed by the Japanese are available to experiment with.

Although the history of bonsai in Japan can be traced far into the past, the styles known as modern were not created until the turn of the century. In the pages that follow, I shall show some examples of modern styles, both standard and unconventional, as well as a few older ones that you might enjoy trying out.

***Plants Used for Bonsai.*** Turning the pages of Japanese bonsai books, you can see that most of the pictures are of conifers—Japanese white pine, Japanese black pine, Ezo spruce, Chinese juniper and a few others. Among the deciduous trees used are zelkova, Japanese maples, Japanese flowering apricot, pomegranate, Satsuki azaleas, ginkgo and beeches; but this list could go on indefinitely.

The American bonsai grower has no particular trouble obtaining these plant materials, since many of them are stocked by nurseries in the United States. But in addition there are American trees, and also trees native to other lands, which might make good bonsai material. For example, the natural patterns of growth of long-leaved pines such as the American *Pinus palustris* and the Himalayan pine (*P. griffithi*) might lead to the creation of a new bonsai style. Both fothergilla in the southeastern United States and Virginia witch-hazel (*Hamamelis virginiana*) form lovely flowering bonsai, while shadbush (*Amelanchier*) bonsai have handsome flowers, foliage and fruit. Cotoneasters, which are common now in many countries, have already been so widely adapted as bonsai that a new style based on them seems to be developing. Someday there will be a long list of other plants which have been found suitable for bonsai training.

## Making Bonsai without Wire Coiling

It is possible, and very interesting, to train a plant from nursery shrub to finished bonsai without wiring any part of it. Indeed, I firmly believe that the real taste and charm of training bonsai lie in forming them without resorting to

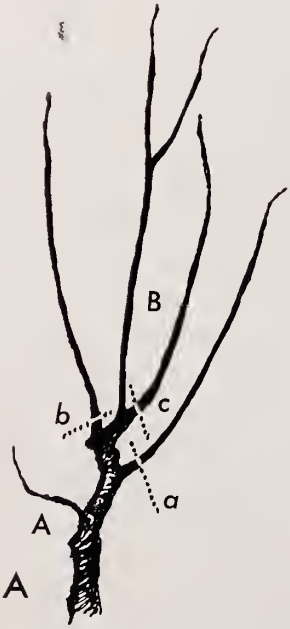
wire coiling. Not only are wired branches sometimes unsightly for years, even when the wiring is done by an expert, but the mechanical process may lessen the interest and pleasure of many enthusiasts. It seems to me that this is one of the reasons why the majority of the garden-minded Japanese have no special interest in bonsai. To be generally popular with garden lovers, plants should be trained by more natural methods. But I must admit that this opinion would be opposed by many first-rate bonsaimen—for example, by Saburo Kato, who presents the case in favor of wiring in his article on Ezo spruce (page 70).

In my view, however, one can easily make many deciduous flowering trees and shrubs into bonsai without wire coiling. Only a few guy wires and proper methods of pinching and pruning are necessary. For example, drawing **1A** shows an ordinary forsythia shrub selected from a nursery row. The branches *a, b* and *c* are removed, and it is planted in a container in the autumn. Just before the buds open in the spring, the slender trunk (*B*) is lowered and fastened by means of guy wires at points *e, f* and *g*, as shown in drawing **1B.** The weaker branch *A*, which is now at the top, will begin to grow vigorously and form a nicely branched head that can be scissors-trained into some shape such as the one illustrated. In the first year of training, shoots will appear all over the trunk, especially where it is curved downward. Some of these should be rubbed off, and others should be pinched back after they have grown an inch or two so they will branch and re-branch.

If you wish to make a semi-cascade instead of a full one, cut off the trunk at point *f* or a little below it. If you want

1 B

Training without wire coiling




1 A

Pruning cuts for nursery-grown forsythia

a slanting-trunked bonsai, remove the trunk somewhere around *d* or *e*. In both cases the drastic pruning will stimulate strong new shoots which will require attention for the first two years of training, since they can spoil the design if they are allowed to grow.

## Making Bonsai with Wire Coiling

If you are determined to practice wire coiling in spite of its disadvantages, the most important advice I can give you is that in anything to do with wiring, never be in a hurry. This applies not only to practicing with wire but also to learning the principles of wiring, for it is the hands which must do the learning, slowly and repeatedly, until they can think for you. The novice who grasps the idea in a few minutes and is able to wire a foot-long branch in seconds has not mastered —I would almost say, will never master— the technique. I have an old friend who is an expert wire coiler by profession, and whenever he tells me about wiring he is never satisfied until he takes me to a bonsai and, fitting my hand to his, coils wire for a time to show my fingers how to do it. He says this is the only way he can explain.

Several decades ago M. Makino, an ardent fancier of Satsuki azaleas (*Rhododendron indicum*) who had grown them for twenty years, decided to learn to train them into bonsai. After years of experience, he became the most skillful wire coiler of azaleas of his time. For Americans who are interested in wiring, drawings **2A** and **2B** show examples of his technique.

The azalea in drawing **2A** had been grown in a greenhouse from a cutting for three years and was 6 feet high. The problem was how to shorten such a very tall plant; if it were made into a twin-trunked bonsai, for example, it would be too tall, and its few branches would not fill out the design. By forming it into a cascade as Mr. Makino did, he created an interesting design. He had difficulty in preventing the stems from breaking, however. He warns that wiring which is as extensive as this should be done not all at once, but gradually, from the trunk to a branch and from one branch to the next, with intervals of some months. The whole process might take a year or so; otherwise breakage is likely.

Drawing **2B** shows a Satsuki azalea, variety 'Kwaho', a favorite with azalea growers in Japan. In wiring a plant like this, Mr. Makino generally protects the bark with hemp. He uses no. 10 and no. 15 copper wire for the trunk, coiling so that the spirals are 2½ inches apart. Then he shifts to thinner wire for the branches and places the spirals closer together. Next, protecting his right hand by wrapping it in a towel, he uses it to grasp the foot of the trunk, while he takes hold of the tip with his left hand. Gently and gradually he bends the tree into its main curves. He moves his left

Training with wire coiling: Height of this 6-foot azalea has been minimized.

*Roche*

"Trees growing on mountaintops, and in other places where constant winds blow, can assume fascinating shapes." Atlas cedar (*Cedrus atlantica*), Okamura-trained.

hand to the middle of the trunk and bends the minor curves into the lower half. Last, he grips the middle of the trunk with his right hand while with his left curves the upper half.

It is best to do this wiring sometime in the period from late fall to early spring. And unlike the procedure with most plants, the wire should be removed within a year. Otherwise it will cut into the bark, for azaleas are vigorous growers.

## Windswept Bonsai

Trees growing on mountaintops, and in other places where constant winds blow, can assume fascinating shapes. It seems to me that this type of bonsai might become a popular style in the United States, though it will probably never be one in Japan because of the disasters regularly inflicted on us by great typhoons. However, Japanese bonsaimen do occasionally create windswept bonsai and windswept forest bonsai as a way of utilizing trees with one-sided branching.

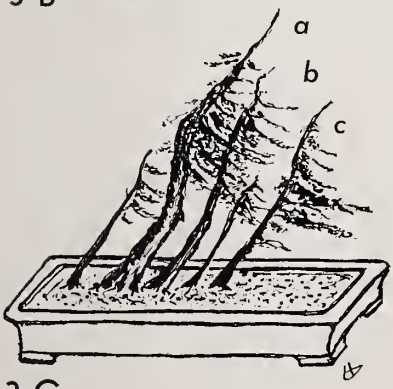
Ezo spruce is a good tree to train in this style, particularly as a forest bonsai. In the windswept forest shown in drawing **3C**, the tips of trunks *a*, *b* and *c* have been stripped to reveal the whitish deadwood often seen at the tops of wind-weathered trees. In this case, where the tips were not as thick as a pencil, the bark was simply peeled away from the wood for a few inches. With thicker treetops, as in the bonsai of drawings **3A** and **3B**, the wood must be worked with a chisel. For example, the branched top of the tree in **3A** was cut off and sharpened, while the top of **3B** was chiseled into a slender deadwood stub. It takes a year or two for these stripped limbs to assume a weathered look so that they appear naturally wind-blasted.

The general rule in windswept design is that nearly all the tree's branches are lowered and trained to grow in one direction, as if from the pressure of the eternal wind. In the case of Ezo spruce, wire training should continue without a break for several years; whenever a branch begins to be constricted, the wire

Training with wire coiling: Azalea wired in one session

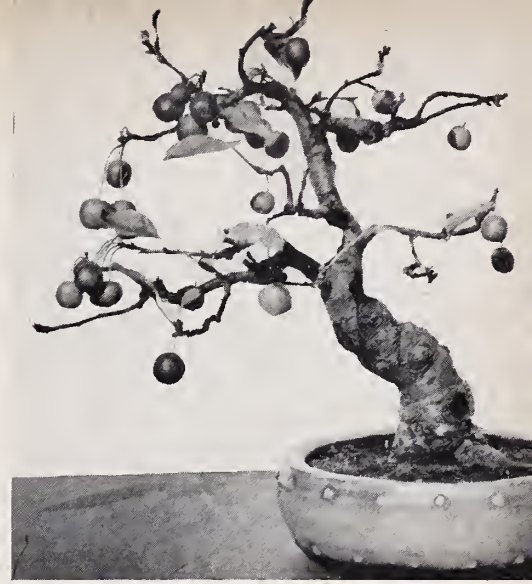
3 A

3 B




3 C

Windswept designs. 3A: Branched treetop was cut off, and stub was sharpened to appear wind-blasted. 3B: Windswept tree with large chiseled stub. 3C: Windswept forest planting.



*Buhle*

"A good fruit-tree bonsai, bearing a few fruits and placed as decoration in the living room or an alcove, has a refined tastefulness which makes this a most desirable bonsai type." Flowering crab apple, Holsten Collection, Brooklyn Botanic Garden.

is loosened or removed and replaced with a new one. Sometimes it happens that a branch becomes longer and more vigorous than the others and starts to weaken their growth. This branch can be shortened by shaping it into rippling curves, which enhance the beauty of the design as well as retarding growth and bringing the tree's development back in balance. In windswept compositions the twigs on the branches should not be allowed to sprout densely, for then the fascinating streaming lines of this style will be lost. How to make every twig show the effect of the wind's sculpturing is a pleasant difficulty which adds to the enjoyment of training windswept bonsai.

## Bamboo Bonsai

Many American bonsai growers may not know that bamboo thrives as a house plant; indeed, few plants can surpass it as material for indoor bonsai. Besides this point in its favor, the fact that wire is not used in training it pleases those of

4 A

4 B

4A: Dwarf bamboo—easiest of the bamboos to grow as bonsai. 4B: A larger-caned variety.

us who may not care for wiring. Here are directions for making three types of bamboo into bonsai.

1. The easiest bamboos to grow in a container are the very dwarf and hardy varieties such as the one sketched in drawing **4A.** *Arundinaria simoni chino, A. pygmaea* and some kind of *Sasa* fall in this category. From a bamboo planting in a garden, carefully dig up a handful of slender canes in early spring before the new shoots come out. Plant them in a container and trim them well, either shortening them considerably or cutting them back to the ground. After potting, water them until they are saturated. In early summer, cut off the leaves so that smaller new leaves will form. Every spring when the new shoots appear, thin out some of the older plants to preserve the balance of the arrangement.

2. In the case of thicker-caned bamboo — *Arundinaria hindsi, Phyllostachys bambusoides* and *P. nigra*—as shown in drawing **4B,** first find some comparatively shallow-growing stems with promising buds. You might discover a very small already-formed plant in an oriental shop. In colder climates, plant in a protected coldframe for the first winter, and in spring when the shoots have grown a few inches, dig up the whole plant, wash the soil off the roots and replant in the ground. This will considerably reduce the size of the new growth. If growth is still too strong, decrease the amount of water and sunlight the plants receive. In early summer, cut off the leaves to develop smaller new leaves, and the plant is then ready to pot as a bonsai which can be enjoyed immediately.

3. The thickest-caned of the bamboos, tortoise-shell bamboo (*Phyllostachys heterocycla*), is a very interesting one to train (and is edible, incidentally). Propagation is by the method described in the preceding paragraph, except that when the young shoots are a few inches high, their sheaths should be peeled off as each new leaf appears. This process reduces the distance between nodes, inhibits growth and helps to dwarf the plant.

## Fruit-Tree Bonsai

A good fruit-tree bonsai, bearing a few fruits and placed as decoration in the living room or an alcove, has a refined tastefulness which makes this a most desirable bonsai type. Since it takes time to create such a planting from the regular one- to three-year-old nursery stock grown for orchards, I recommend that you look for old fruit trees which have passed their age limit but are still healthy at the base. Or a plant such as a small-leaved orange tree which has been grown for years as a house plant can be repotted and retrained as a bonsai.

As an example of the use of old fruit trees, the bonsai grower who finds a pomegranate tree with decayed heartwood and only a thin layer of living wood can saw it off 2 to 3 feet above the ground. If all the thick roots are cut back close to the trunk, it can be grown successfully in a container with no more than the usual care. Young shoots will spring up vigorously, and from them a few should be selected for training. This procedure is also frequently used with Japanese apricot, and to a lesser degree with the other rosaceous fruit trees. All are beautiful as flowering bonsai, and they can be induced to fruit. Choose types with small-sized fruits, however.

An orange tree with small leaves which has been grown as a house plant can easily be made into one of several bonsai styles. To create the semi-cascade shown in drawing **5A**, the unnecessary branches were pruned away and the tree was planted in the container at a slant. After it was settled and growing well, the trunk and branches were curved by wiring. Although orange trees are not difficult to wire, their bark is easily damaged and should be wrapped with cloth before the wire coiling is begun. The weak *A* branch shown in the illustration will grow sturdily now that it has been brought into an upright position, for one characteristic of orange trees is that the top growth is strong.

Persimmon trees make colorful bonsai with deep orange-red fruit and flaming

5 A

5 B

5A: Semi-cascade bonsai made from an orange tree which had been a house plant. 5B: Persimmon bonsai created by pruning a full-sized tree back to its lowest limb.

6 A

6 B

Twin-trunked bonsai. 6A: A pair of trees planted close together. Hinoki cypress, Ezo spruce, cryptomeria and other delicate-foliaged varieties are suited to this style. 6B: A single Japanese white pine with forking trunk.

autumn tints. When a suitable tree is found, often it can be given its main shape as a bonsai simply by cutting it back to the lowest limb. Sometimes, as shown in drawing **5B**, a stub of the trunk is left on as a picturesque feature, since this is the way trees in orchards are frequently pruned. Further training with wire must be done carefully because of the brittleness of persimmon branches.

## Twin-Trunked Bonsai

As drawings **6A** and **6B** show, there are two kinds of twin-trunked bonsai: a pair of trees planted so close together that they seem like one, and a single tree whose trunk forks near the ground. Twin-trunked bonsai have a less grand and dignified appearance than the formal single-trunked bonsai which the Japanese admire so much. They are easier and quicker to make, however, and are so interesting to design that the owner learns many principles of bonsai while he amuses himself in training them.

Whenever we come to select potential bonsai from nursery rows, we find only a few that are desirable for orthodox single upright trees. If we look again at the others, however, we discover some that will make nice twin-trunked arrangements. When choosing trees to plant as a pair, find two that combine well not only in branches but also in their root systems; roots which lie on the surface should not cross each other, for example, and the root systems of both trees should be approximately equal in size and vigor.

Then, as you would with any bonsai, thin and shorten the roots and branches of the two trees and plant them together in a container.

Train two-tree bonsai by wire coiling—in this case, a thorough wiring which involves every branch. Forming the overall shape is relatively easy, and so absorbing that you may find you have overwired. With these bonsai, however, excessive wiring is not so objectionable or injurious to the tree, particularly if one takes care to coil the wire evenly and use the proper wire sizes. In positioning the

branches, remember that the foliage should be arranged to give snatchy views of the two trunks all the way to the top. The branches of conifers are generally lowered, while those of deciduous trees are wired to grow either horizontally or upward, depending on how the mature specimens appear in nature.

The tree in drawing **6B**, a dense forked-trunk pine bonsai that has become a favorite in Japan, is shaped by considerably less wiring than a two-tree composition. After a few years of basic wire coiling to arrange the main branches, it can be trained entirely by selective pinching of the new growth and occasional thinning of the branches to allow more sunlight to filter deep into the tree. While the wire is still being used, be careful that it does not constrict the branches. A fine bonsai in this style is shown in color on page 46.

### Three-Trunked Bonsai

Between single-tree bonsai and forest bonsai lies the charming arrangement of three-trunked bonsai. This composition presents slightly different problems of design and culture from the other styles, although some bonsaimen consider it a version of forest bonsai. For example, see on page 27 the three-trunked bonsai which Seizan Ito discusses as part of his article on miniature forests. The intimate harmony of that planting of three beeches is a characteristic of the three-trunked style.

Drawings **7A** and **7B** illustrate other three-trunked designs—a modern one in A and an older version in B. The three slender-trunked pines in **7B** are too thin to use as single bonsai, but they make an appealing arrangement when planted very close together. In **7A**, each tree not only contributes to the design of the whole, but has an individual beauty as well. The closely integrated relationship between the trees is the important element in both designs and should be the central concern in their training. In addition, since there will inevitably be a struggle for survival among trees in such a small container,

7 A

7 B

Three-trunked bonsai. 7A: Modern version. 7B: An earlier style, in which trees are too slender to use as single bonsai. Japanese white pine is well suited for both versions.

the bonsai grower must know which tree is the weakest so that he can give it extra care. Because the trees are so intimately related, these compositions are not simple to re-form if one of the plants dies.

The individual trees in a three-trunked bonsai are larger than those in a miniature forest, and the roots are not easy to establish in a shallow container. Plants should be used which can be made to produce good fibrous roots by means of root pruning. Japanese white pine is particularly suited to three-trunked bonsai, since it responds well to root pruning, pinching and wiring.

Generally, trees of the size used in three-trunked plantings produce exceptionally long and strong roots growing around the inside edge of the container. To reduce these, take hold of one or two of the trees and lift the plant out of the container; the ball of the soil usually comes out easily. Then prune the long roots drastically—or remove them completely if you judge that the plant has enough shorter roots to survive—and replace the planting as it is. In reality, this is a quick partial repotting procedure. Add more soil mixture to the container before replacing the root ball.

### Clustered Bonsai

Of the clustered plantings in **8A** and **8B**, A is a modern style, B an older one. I like both equally well and recommend that both be tried out with small nursery stock.

To make a planting like **8A** from Japanese maple seedlings, group seedlings which are 12 or more inches high close together in an ordinary deep flowerpot. Keep them there one, two or even more years, meanwhile pinching and pruning them and cutting back the tops to give them a symmetrical shape. When the main roots are thick and deep enough, move the clump to a shallow container, exposing the tops of the roots as shown. If the weather at that time is dry and windy, protect the exposed roots at first with moistened sphagnum moss. Since maples are very breakable except for the

8 A

8 B

8A: Modern version of clustered maples.
8B: Earlier clustered style, appropriate for birches, beeches and other slender-trunked trees.

*Yoshimura*

"When choosing trees to plant in a pair, find two that combine well." Ezo spruce and other very short-needled varieties are suited to this style.

young shoots, be careful about wiring, especially toward the nodes. Pinch back the new shoots every spring to induce denser foliage. Although (as with all bonsai) it is desirable to use varieties with small leaves, dwarf maples are not appropriate for cluster plantings, because their growth is too dense and shrub-like.

Among the suggestions I have given here, some of them easy for a novice, some technically more demanding, some traditional in Japanese bonsai design and some quite free and informal, I hope everyone can find a few styles he would like to experiment with. In Japan, bonsai styles have not remained fixed in recent years: since World War II, flowering bonsai have become more popular, the number of "light" designs as opposed to formal, balanced compositions has increased, and the overwhelming prepoderance of the conifers has somewhat moderated. As styles which are distinctively American begin to be developed by growers in the United States, Japanese bonsai fashions may come to respond to influences from the West even as Japan's styles have influenced western designs. ✦

Pines from the collection of Heizaemon Ishihara of Nagoya, Japan. Above: left, 70-year-old Japanese black pine; right, Japanese white pine said to be 500 years old. Below: left, 100-year-old Japanese black pine; right, 150-year-old Japanese white pine.

# STONE-CLASPING BONSAI

Seizan Ito

*Faraway islet, seabeach or rugged cliff can be suggested by bonsai growing on stones*

THE objective in creating a stone-clasping bonsai is to reproduce in a container the effect of a mountain landscape with bold cliffs and steep ravines. In the version of this style now fashionable in Japan, the tree is subordinated to the rock, whose shape and color are the features emphasized for appreciation. The plants, which should be low-growing, with exposed heavy roots, are placed as appendages to the top or side of the stones, as in the multiple-tree rock planting below.

Trees are subordinated to the stone: A multiple-tree bonsai. These trees are small in relation to the pinnacled rock.

In other versions of stone-clasping bonsai, which are shown on the following pages, the stone is an accessory to the tree. For example, the bonsai seems to hold a stone at its foot, or its roots are trained over a stone so that their formation can be appreciated.

As with forest bonsai, the loveliness of stone-clasping bonsai lies in their presentation, in miniature, of scenes copied from nature. They should convey the feeling of a grand view of a mountaintop, or an islet in our Inland Sea. Just as a painting reproduces a natural landscape, so the scenery of seabeach, islet or perpendicular cliff can be re-created with living plants in a small container.

### Advantages of Stone-Clasping Bonsai

- Young trees can be used, and so can "defective" trees which would not make good formal upright bonsai. Thus a fine stone-clasping bonsai often can be created from ordinary plant materials.

- A bonsai which has a finished look can be made in a short time. Then as the planting ages, it becomes even more attractive.

- Stone-clasping bonsai are easy to create; a novice can soon learn to make

an interesting one. They are also easy to remake if the tree grows out of scale or the owner decides to change the design.

### Selecting the Stone

When looking for stones to use in this kind of planting, remember that rugged, jagged and oddly shaped ones are best for evoking the grandeur of a wild landscape. Choose rocks from a mountainside rather than from the bed of a river, where they will have been smoothed by the water's action. However, the base of the stone must be stable; a tree planted on a teetering rock will not grow properly, if at all. If the bottom is not already flat, it should be worked in order to form a steady base. Another practical consideration is the weight of the rock; do not choose one which is too heavy to carry unless the finished bonsai will have a permanent location.

Besides valuing picturesque shapes, the Japanese appreciate stones which contain different colors and textures. A cascade stone, for example, has a smooth white streak down it that gives the effect of a mountain waterfall. Other stones with white outcroppings can be used to suggest winter landscapes. In addition to such scenic effects, the colors of varie-

Tree subordinated to the stone: Japanese white pine on a cascade stone. Note the narrow white streak that suggests a mountain waterfall. The stone is placed off-center in a basin of water or gravel.

Bonsai holding a stone at its foot: When this tree was young a small stone was set between the main roots, which grasped it as they grew and thickened.

gated stones are lovely in themselves and set off the colors of the trees planted on them.

Although it should possess some of the dramatic features suggested here, a rock for a stone-clasping bonsai need not be perfect. A stone with several good points can be used effectively even if it also has an ugly face, for this can be concealed by well-placed plantings. The stone-clasping bonsai pictured on these pages will give some idea of the many shapes and types of stones that can be planted to create miniature landscapes.

### Plants for Stone-Clasping Bonsai

As with all bonsai materials, plants chosen for stone-clasping bonsai should have small leaves. This is especially important when the planting is meant to suggest a faraway scene. Among the more desirable specimens are Ezo spruce, Japanese white pine, Chinese or similar kinds of juniper, and small-leaved rhododendrons and azaleas.

In addition to the main tree or trees, stone-clasping bonsai often include mosses and other creeping plants which have small shapely leaves. Dwarf ivies and dwarf woody plants such as *Rhododendron serpyllifolium* can also be used as secondary plantings.

Roots trained over a stone: Trident maples. The tree at left took 30 years to develop its strong roots. At right the densely formed branches are for winter rather than summer appreciation.

### How to Fasten the Tree Completely to the Stone

To create the version of stone-clasping bonsai in which the tree is subordinated to the stone, fasten the bonsai to the face of a comparatively large rock by the steps given below. The mass of soil placed around the tree roots (as in the cross sec-

Trees are subordinated to the stone: Ezo spruces and secondary plantings in a large stone-clasping composition. Plants with tiny leaves are essential when the bonsai represents a distant landscape.

tion shown in drawing E) is all the soil the tree will ever have, and it is necessary to use a special mixture.

***Season.*** Although early spring (just before growth normally starts) is the best season for making this type of bonsai, some species can be planted and trained at other seasons. If planted in summer, the tree must be carefully shaded until it becomes settled on the stone; if in winter, it must be protected from freezing weather.

***Soil.*** The soil in this type of planting must have enough fibrous substance to hold it together, yet enough clay-like material to stick to the sides of a stone and to retain moisture. Japanese bonsaimen use a mixture of powdered mountain moss, powdered blackish and reddish clay, and *Ketozuchi,* a soil formed in lakes and marshes from the decay of organic matter.

Inasmuch as these special materials are not available outside Japan, each grower will need to experiment with soils in his locality. One possibility is to combine 2 parts clay, 1 part finely screened peat moss, and a small amount of some shredded material such as dried sugarcane fiber (Stayz-Dri), dried shredded cornstalks, or fine nylon string cut into ½- to 1-inch lengths. Before it is spread on the stone, the mixture should be formed into a paste by adding a little water and stirring thoroughly. If the paste does not adhere well to the stone, more clay can be added to the first layer of soil which will be spread on the rock surface.

Bonsai planted on a rock slab: A flowering apricot growing in soil heaped on the surface of a flattish stone. Such bonsai are never repotted; fresh soil is added from time to time.

***Steps in Planting.*** Soil, tree and moss are attached to the stone by the following methods:

1. Select a position for the tree where it will not conceal the good features of the rock. Using an adhesive such as epoxy cement, glue a few rings made of slender copper wire around the spot chosen. See drawing C for examples of ring placement in three possible tree positions. The rings should be about ½ inch in diameter and can be shaped in any of the ways shown in drawing B. After the glue has hardened, tie very slender copper wire to the rings as illustrated in drawing D.

2. Prepare the soil mixture described above, moisten it to a paste and spread it ½ inch thick over the area on the rock where the tree is to be planted. (Add more clay if the soil will not stick to the stone.)

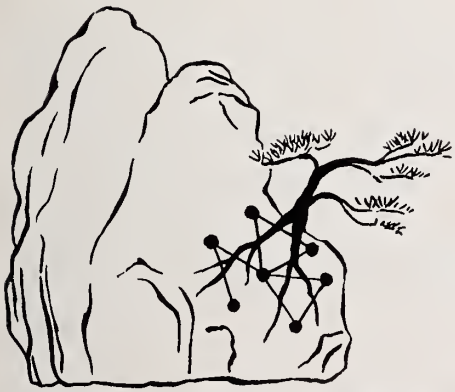
3. Unpot the tree and gently shake or wash off all the soil attached to its roots. Do not prune the roots; rather, spread and press them lightly into the soil mixture on the rock. If they seem to be drying out as you work, spray lightly with a fine mist.

4. Fasten the roots with the very slender wire as shown in the cross-section sketch of E. Notice that a thin piece of rubber is placed where root and wire come into contact, in order to prevent damage to the root. The general idea of fastening the roots with wire is illustrated in A, where the circles represent the rings glued to the stone.

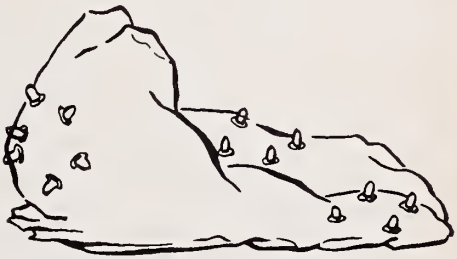
5. After the roots have been fastened, spread a second layer of the soil mixture on top of them. Also apply soil to areas where the roots will reach in the future. Use enough of the mixture for the tree to grow in; remember that this is all the soil the plant will have.

6. Cover the soil with a low-growing or creeping moss. To do this, use a knife to scrape away all excess earth from the underside of the moss mat. Apply a thin coating of finely powdered loam to the

B. Rings of ½ inch diameter can be shaped in any of these forms.

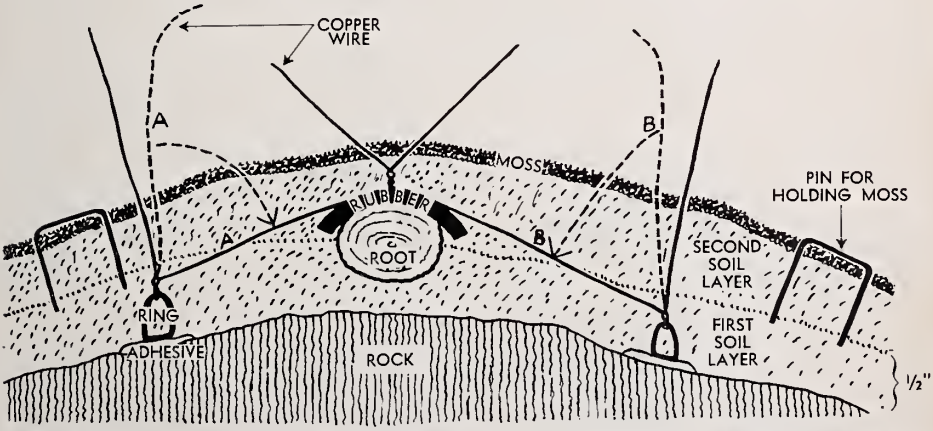


A. The general idea: As sketched here without soil and moss layers, tree roots are laced to rock with wires passed through rings. Circles represent rings glued to the stone.

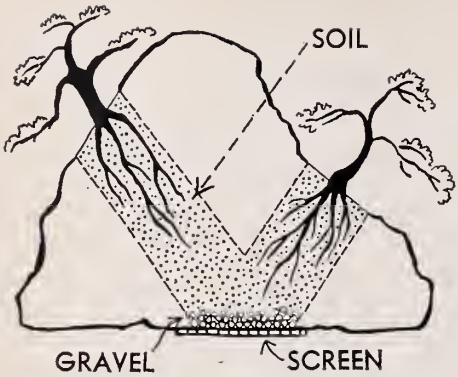


C. Copper wire rings glued to stone in three possible tree positions.

D. Very slender copper wire is tied to rings after glue has hardened.




E. Sectional diagram showing root in relation to soil layers; note how wires hold it in position.




Trees planted in holes drilled through the stone appear to be stone-clasping bonsai, but care is the same as for bonsai in containers.

scraped underside, spray it lightly with water, and turn the moss over and press it into the soil of the rock planting. Sometimes several kinds of moss are blended together. Occasionally underplantings of herbaceous species are used instead of moss.

7. Since the main role of the mosses is to prevent the soil mixture from washing away, they should be firmly attached to the soil. For this purpose, make U-shaped pins from slender copper wire and use them to fasten the moss as shown in drawing E. Be sure the pins are long enough to hold, and insert enough of them at different angles and in different places to make the planting secure.

8. Water the bonsai thoroughly with a fine spray.

### A Tree Planted in a Hole in the Stone

As shown in the drawing above, bonsai made by this method look as if they had been planted using the techniques listed in the previous section, but actually they grow like trees in containers. The holes they are planted in, which can be made with a drill by a stonemason or stone monument maker, should extend through the stone to the bottom. Their diameter is usually about 2 to 4 inches, although some large plantings in outsize stones may require larger holes.

Planting procedures resemble those for regular bonsai. Copper mesh is glued across the bottom of the hole, a drainage layer of gravel is added, and regular bonsai soil (*not* the special stone-clasping mixture) is used. As with bonsai in traditional containers, the trees are periodically removed for root pruning and then replanted with some fresh soil.

### Training Roots Over a Stone and Into Soil

In this version, the tree is planted with the main roots astride a stone, as if it were on horseback. The rock is set into a shallow container, and the roots are led down into soil.

As this kind of planting ages, the gnarled and twisting roots themselves become one of its beautiful features. In following their own style of growth and accommodating themselves to the shape of the stone, the roots of every tree form individual patterns. Two trident maples shown on page 19, for example, have quite different patterns of roots. Pictured in color on page 43 is a particularly fine bonsai trained over a stone—an azalea with ancient roots twined and plaited like a woman's hair.

Techniques for fastening a tree to a stone, and for protecting the roots until they are well established, are given on page 88.

### Care of Stone-Clasping Bonsai

• *Watering:* Since these plantings dry out more quickly than bonsai in containers, they usually need at least one extra watering on sunny days. In all weather they should be watched closely to prevent excessive dryness; frequent watering is the most important single element in the care of stone-clasping bonsai.

• *Fertilizing:* Instead of manure, which is difficult to apply evenly to rock plantings, weak liquid manure or other liquid fertilizer should be given several times during the growing season.

Many shapes and types of rocks can be used to create fine bonsai. This red stone of a kind found near Kyoto has the profile of a stream running between raised banks. The main planting is of Japanese white pine; the secondary planting at far left is *Rhododendron kiusianum*.

• ***Replacing soil:*** Trees which are growing exclusively on the stone are never repotted or root-pruned. Instead, the moss is lifted off every few years and additional stone-clasping mixture is spread on the roots to replace soil washed away by watering. My experience with a variety of Ezo spruce called 'Yatsufusa' has been that the trees develop faster when planted on a stone rather than in a container, but that growth becomes poor after a decade or more, owing to the prolonged scarcity of soil. Then I find I must move the tree to a container to recover, while I plant a younger one in its place. Perhaps other species may need the same treatment after they have spent many years on a stone.

• ***Repotting:*** For trees which are trained over a stone and into soil, the soil in the container is renewed periodically, as in the case of ordinary bonsai. The tree should never be separated from the rock, however; tree and stone are gently tapped out of the container together, and the roots which were growing in the soil are pruned in the regular manner. Fresh soil is added to the container, and tree and stone are set back into it as a unit. ✦

A view of deep forest: Straight-trunked Ezo spruces, of the same age but with varying heights and thickness of trunks. Trees which branch densely on only one side are usually placed at the sides; those with low branches are often planted at the back.

# FOREST BONSAI

*In a well-composed forest, one can almost hear a birdsong, or the sound of a running brook*

**Seizan Ito**

IN a forest bonsai a number of trees are arranged in a container so that they suggest a woodland scene—for example, a view of deep forest, woods on a seacoast or a plain fringed with scattered groves. Like stone-clasping bonsai, forest plantings have immense variety in subject matter. They can show close-ups or faraway perspectives, young forest or old, dense growth or sparse wind-battered trees; there seems no end to the effects which can be produced in this free and informal bonsai style.

Trees set haphazardly into a container, however, will not give the illusion of a natural landscape, no matter what scene is being created. Because it is a work of art made with living plants, a forest bonsai requires the same attention to composition that one finds in a good

painting. Ultimately it must suggest not only the appearance but the mood of a forest; it cannot be called a fine bonsai unless one can almost hear a birdsong from its interior, or the sound of a running brook.

In Japan, even such a forest masterpiece is less expensive than a single tree in the traditional formal upright style, because the materials used in forest plantings are relatively low in price. Trees which have impressive trunks, evenly developed spread of roots, and correct branching required for orthodox single bonsai are rare and costly. Bonsai nurserymen often refer to other trees which do not meet such rigorous standards as "materials for forest bonsai." These less-than-perfect trees show an individuality which can contribute to the special charm and grace of forest plantings. A fine forest created by an expert bonsaiman has a poetic quality which reflects his feeling for the loveliness of nature as well as his great technical skill. Such a man will sort through scores or even hundreds of trees to find five or ten for his forest scene.

Faraway perspective: Japanese white pine in a forest planting. To create a bonsai like this, the grower must develop an awareness of principles of composition that one finds in a good painting.

Woods on a seacoast: These Ezo spruces are actually one root-connected tree.

## Advantages of Forest Bonsai

Besides the great advantage that less-than-perfect trees can be made into attractive forests, plants too young to have ornamental value as single bonsai can also be used. It depends mainly on the skill with which they are arranged. And although trees in the formal upright style take thirty to fifty (or with some species, even a hundred) years to become finished bonsai, it is possible to compose a forest that can be appreciated and enjoyed immediately. If the materials are already assembled and the design has been planned and sketched beforehand, the bonsai can be made in one sitting.

With the passage of time, a forest bonsai, like a stone-clasping one, becomes increasingly harmonious and well composed. After years of cultivation and training, it has a charm quite different from the poised dignity of a single fine bonsai. Because of the informality of this style, a forest bonsai can easily be recomposed if part of it is damaged or becomes weakened in growth. Sometimes changing the position of only one tree is enough to form a new design.

It is possible for beginners, especially those with some experience in art, to create most pleasing arrangements in this style. And since inexpensive plant materials can be used, beginners can experiment freely in order to develop skill with forest composition.

## Plants for Forest Bonsai

In selecting plants for forest arrangements, bonsaimen prefer certain characteristics that may be found in many species, both evergreen and deciduous:

- As with all bonsai, small-leaved trees should be used in a forest planting.
- Because most forest containers are very shallow, species which take kindly to severe root pruning are best.
- Ideally, all trees in a forest should be of the same clone—that is, propagated from the same parent plant. Their identical growth habits make the bonsai easier to care for and more unified in appearance.
- It is rewarding to use trees whose new sprouts characteristically are lighter in color than the older growth. The foli-

A plain fringed with scattered groves: Zelkovas in the winter. Composed to give a feeling of vast space.

Close-up: Three beeches with some herbaceous plants. Trees which would be less than perfect as single bonsai often have an individuality which contributes to the special charm of forest plantings.

age then provides exquisite color contrasts during the growing season.

The most suitable forest species are Ezo spruce, cryptomeria, Hinoki cypress and needle juniper among the conifers; and beeches, hornbeams, maples and zelkovas among deciduous trees.

Both for appearance and for the health of the plants, it is best to use only one kind of tree in a forest. Occasionally a good forest bonsai contains a mixed planting, but in order to avoid a garish effect the designer is careful to make one species dominate the composition; he uses only a few of the second kind as accents. Even so, the different rates of growth of the two species sooner or later destroy the balance of the arrangement; the stronger variety tends to dominate or starve out the weaker.

## Containers

In general, the container should be very shallow to add to the feeling that the forest is tall and spacious. Shallow oval or oblong containers are well suited for most forest plantings, though slender-trunked trees arranged in a strip, as the Ezo spruces on page 25 are, look best in shallow rectangular ones. Flattish, often slightly concave stones, like that used for the forest bonsai on page 47, also make excellent containers because they contribute to the "natural" character of the planting. In Japan such stones from Kurama, Kyoto, are greatly prized.

## Soil and Season

Since regular bonsai soil is used in forest plantings, whatever mixture has been satisfactory for growing a single bonsai can be duplicated in a forest made from the same species. As for the best season to create a forest, it is the same as the best season for planting and transplanting all bonsai: early spring just before the buds begin to open. At this period the severe root pruning often needed because of the shallow containers is less likely to kill the trees. Forests can also be made at some other times of year if

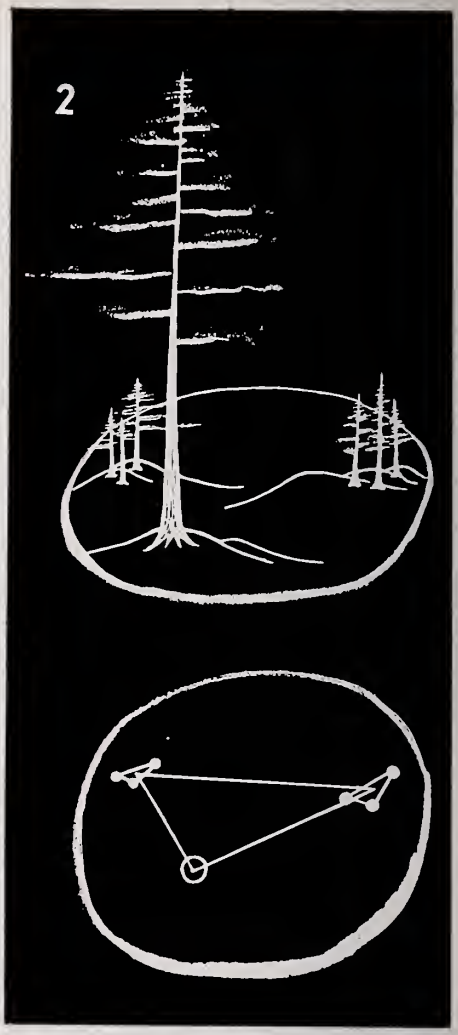
only moderate root pruning is required; but midsummer and midwinter are to be avoided.

## The Design

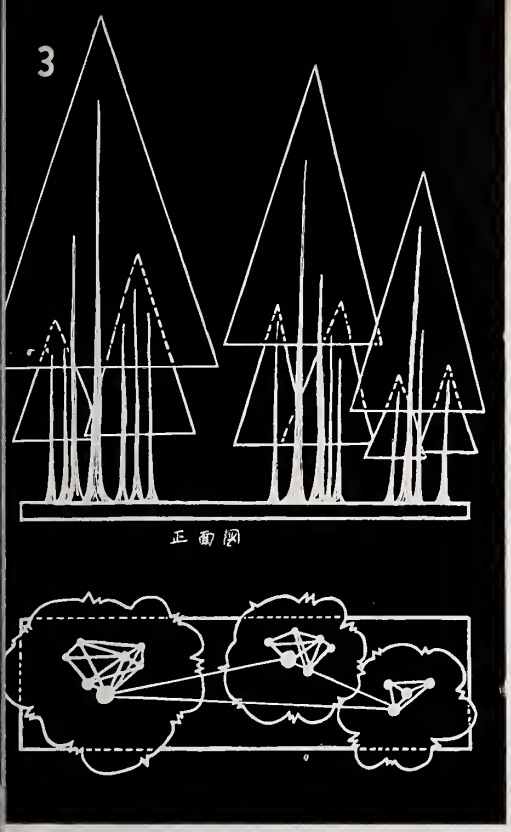
The overall design of a bonsai forest comes from the arrangement and varying sizes of the trees; the general principles behind the design are the same as those for the composition of a painting or a piece of sculpture. Bonsai growers who have had no training in art will learn these principles as they experiment with group plantings and see which ones take on the appearance of a natural landscape. Here are a few guiding suggestions:

- In general, an odd number of trees is used in each small cluster within the arrangement, as well as in the planting as a whole. This helps avoid symmetry and gives the random appearance of a natural forest.

A forest family, with trees A, B and C, the grandparents and parents, serving as the focal points.




Front elevation and ground plan using uneven triangles to create irregularity and depth. Perspective is emphasized by mounding the soil into tiny hills.




Front elevation and ground plan for a straight-trunked forest bonsai. Suitable for use with Ezo spruce, cryptomeria, needle juniper and other conifers.

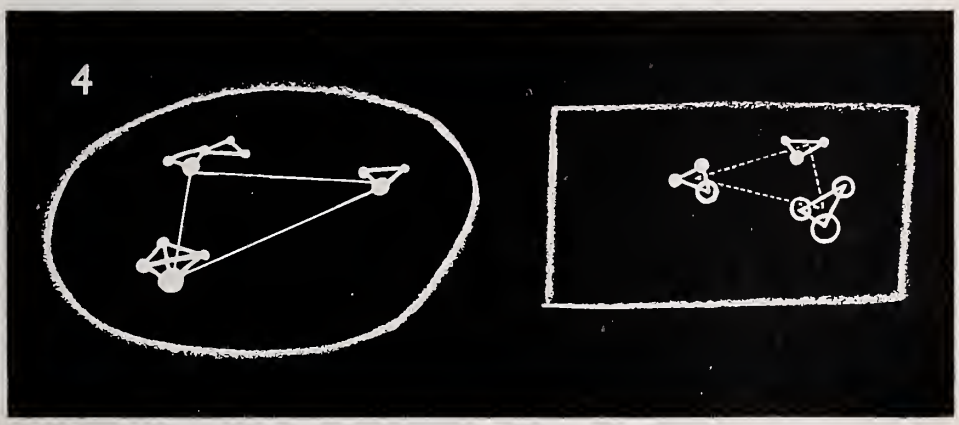
• Just as a family consists of parents, grandparents and children, so a forest bonsai has a main tree and a secondary main tree around which the less important trees are grouped like children, as in drawing 1. The arrangement should have a family feeling of unity and harmony.

• One commonly used ground plan is an uneven triangle with the three main trees at its vertexes, and with the other trees forming smaller triangles around these. The sketches in drawings 2, 3 and 4 show the idea. Such an organization results in fairly definite clusters of trees and a focal point that is off-center. This can help create the impression of irregularity and depth given by an actual landscape.

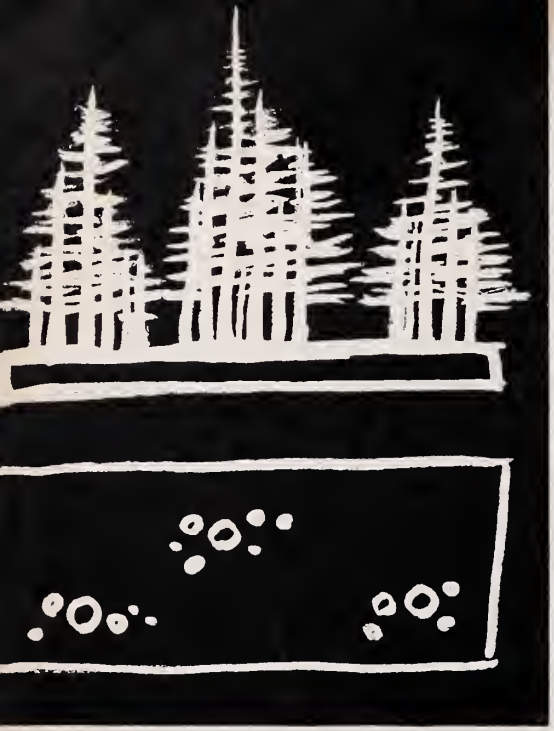
• Trees that are branched thickly on only one side are usually placed at the sides of the arrangement, and those with low branches are often planted at the back.

• In some compositions, particularly in large containers, the soil can be graded to give the appearance of a hilly surface.

• The grower should develop an awareness of line, of form, of the shapes of the individual trees and the curves of their trunks and branches. Selecting some of these lines to carry through the composition, echoing and varying them from branch to branch and tree to tree—these are skills which the beginner develops as he experiments, and which can be seen at their highest in the truly great forest bonsai; for example, the Japanese white pine arrangements on pages 25 and 47.




Possible positioning of trees in oval and rectangular containers.



• As with all compositions in the visual arts, the empty spaces are as important as the arrangement of trees. An obvious case is the zelkova forest on page 26, which has been organized so that the space it includes by implication extends far beyond the boundaries of the planting. Learn to notice the different ways in which forest bonsai use space.

• Since the source of music, painting and all the arts is nature, we should copy natural landscapes, learn from them and come to be humble. As the painter fills his sketchbook with forms which catch the eye, so we bonsaimen should sketch and photograph impressive scenery, going out often to view field and mountain.

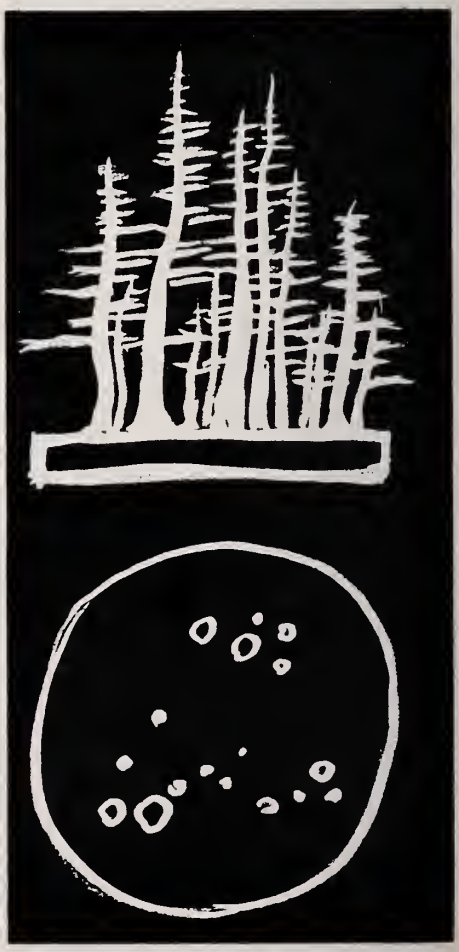
## Making a Forest from Separate Trees

Here is the method used in Japan for planting a forest from separate trees. (If you wish instead to create a forest from a single tree trunk laid down on the soil, see pages 32 and 33 which follow this article.)

1. *Sketch the design.* After studying each tree and deciding how to arrange a forest scene, it is best to draw a ground plan and a sketch of the front view, like the plans shown on these pages. Not only do drawings help in working out the design, but they save confusion in planting. If the composition is a large one with many trees, it may be desirable to sketch the side views as well.

2. *Prepare the container.* As for all bonsai containers, cover the bottom holes with plastic screening. Put down a thin layer of gravel for drainage and a thin layer of bonsai soil on top of it.

3. *Prune roots and branches.* If the trees are potted, unpot them, shake away excess soil and cut back any long roots



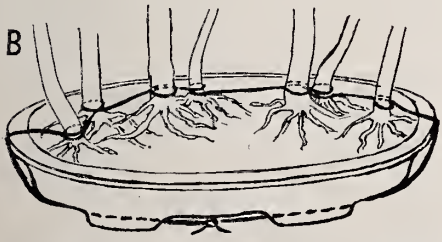
in order to create a compact root system. If some trees have only a few roots which are too large for the shallow container, they may be cut halfway through with a razor blade in one or more places and bent to conform to the soil space available. If much of a tree's root system is removed, then the top must be correspondingly reduced.

4. *Plant trees.* Plant the first few trees in order of size, i.e., the main tree, the secondary main tree and so on. Then, as with any bonsai, firm the soil by jabbing with a chopstick so the dry soil will fall into any air pockets remaining around the roots.

**If trees will not stay in place:** Sometimes it is difficult to position the trees; each as it is planted pushes the others askew so that they do not conform to the plan. For this problem different bonsaimen prefer different solutions:

- As each tree is being planted, some growers wet the soil heaped around it to a sticky consistency. This alone may be enough to hold a tree in place.
- Others prop the tree into position with pieces of moistened moss placed at the foot of the trunks.

Wire through drain holes of container can be used to fasten trees in place.




Trees can be held in position by tying with string, which is passed around and knotted underneath the container.

- When the container is being prepared (step 2), wires can be threaded through the bottom holes before the gravel is spread, as shown in drawing A. Then while the trees are being planted, the wires are tied around the root balls to fasten them in position.
- The trees can be tied to the container with strings by the method shown in drawing B. At about the time when the roots begin to take hold, the strings rot away.

5. *Care and training.* Immediately after planting, the forest should be watered with a fine spray until water runs out of the drain holes in the container. Place in shade, and shelter from wind and rain until new growth has started.

After a few weeks to a month or more, new fibrous roots will have formed and the trees will be securely anchored. Training, whether by wiring or by pruning alone, can then be started.

In about two years, when the container is crowded with roots, the forest is unpotted and root-pruned as a unit. Damaged trees or trees that have become too dominant are replaced, and the forest is replanted with the addition of some fresh soil. ✦

# A FOREST FROM A SINGLE TREE

One of the most easily mastered techniques, offering no particular difficulties for a novice, is the raising of a forest from a single growing tree. Such a forest, being uniform in character throughout, takes on autumn color simultaneously and is simpler to plant than forests composed of separate trees. There are two ways of making single-tree forests. The first, which is described below, is commonly used with deciduous trees. The second, given on the opposite page, is best for evergreens.

—*Kan Yashiroda*

### Using a Deciduous Tree

1. ***Selecting a tree:*** In early spring select a deciduous tree (such as Japanese maple, zelkova or carpinus) with numerous dormant buds. It is preferable to use a tree which has one or two main branches near the base. In general, the more branches the tree has, the more treelets there will be in the future forest.

2. ***Preparing the container:*** Prepare the container as for any bonsai (for example, see step 2, page 30).

3. ***Pruning:*** Prune the trunk and branches severely; when the tree is laid down, it should not be close to the edges of the container at any point.

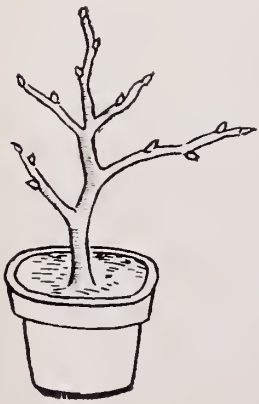
4. ***Planting:*** Lay the tree flat on the soil, remove any roots which tend to point upward, and cover the remaining roots with more bonsai soil. It is customary to place the roots at the left of the container. Bury the trunk and branches up to half or two-thirds of their diameter.

5. ***Securing the tree:*** Fasten the tree in position with wires either threaded through the drainage holes or wrapped around the outside of the container, as shown in the right-hand drawing below. Notice that pieces of rubber are used to protect the tree wherever the wire would touch it.

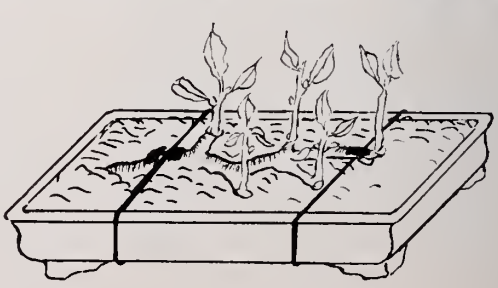
6. ***Watering:*** Water thoroughly, and keep the trunk and roots covered with moist sphagnum moss until the dormant buds start to grow.

7. ***Training:*** When the new shoots are several inches high, select those in the most pleasing positions for training, and remove the others. To create tapering trunks, pinch each shoot back to one of the lower buds, and repeat this procedure as new shoots develop from the dormant buds throughout the growing season. ✦

—Adapted from Kan Yashiroda, *Bonsai: Japanese Miniature Trees* (Branford).



*Left:* In early spring, select a deciduous tree with numerous dormant buds. *Right:* When the tree is pruned back to a single bud on each branch and laid down on the soil in a container, vigorous shoots develop.



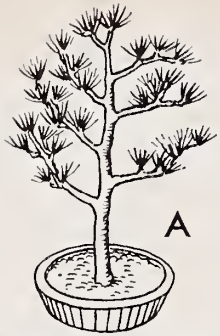
## Using an Evergreen

1. *Drawings A and B:* In early spring when growth is starting, unwanted branches are pruned from an evergreen tree. It is then laid on its side in a box and fastened tightly so that it can be wired with reasonable ease. All the branches are wired to grow in the same direction, and the trunk is wire-shaped to give it pleasing undulations. Further shaping of the branches, which now represent small upright trees, can best be carried out in future years during the spring growth period.

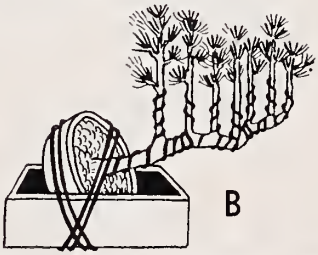
2. *Drawing C:* The container is prepared by placing screening over the bottom holes, threading wire through them, and adding a layer of gravel and a layer of bonsai soil. The size of the tree's root ball is reduced, and any roots that would form too much of a hump in the shallow container are removed completely. Laid flat on the soil, the tree trunk is tied firmly in place with the wires which have been passed through holes in the container. Drawing C provides an "X-ray view" through the soil and gravel to show how the anchoring wires hold the tree. Strips of leather or rubber are used to protect the bark from being cut by the wire. The dotted lines beneath the center hole in the drawing illustrate how the wire which has been threaded through this hole is anchored underneath the container by a short piece of stick or heavy wire.

3. *Drawing D:* The final step is to partially bury the horizontal trunk by adding more bonsai soil. The container is then set in a place which receives strong light but is protected from direct sun, rain and wind. It should not be moved or disturbed in any way for several months so that the branches may be enticed to send forth roots. ✦

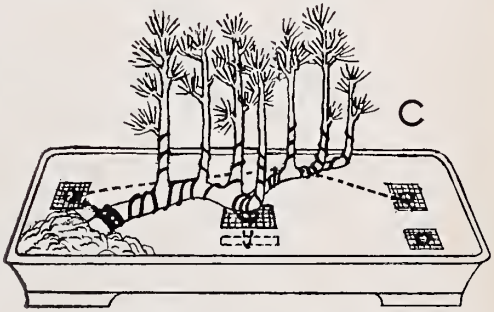
—Adapted from Toshio Kawamoto and Joseph Y. Kurihara, *Bonsai-Saikei* (Nippon Saikei Co., Tokyo).



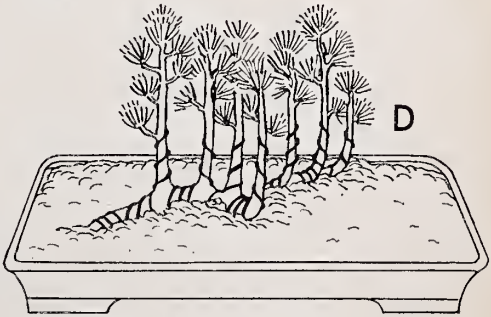

Pruned evergreen, early spring




Tree lashed on side, branches wired to grow upward




Transplanted tree: "X-ray view" through soil to show how wires hold it in container




Final step: Tree with trunk partially buried in soil

# A TRADITION OF BONSAI AMATEURS

*Through the centuries, connoisseurs in Sendai, northern Japan, have created a center of bonsai culture*

**Makoto Inawashiro**

SINCE the sixteenth century, when a great feudal lord then ruling this territory began to encourage the growing of bonsai, Sendai has been a focus for bonsai art in Japan. The lord was interested in bonsai (as well as in Noh plays, painting, Waka poems, and tea ceremony) as a pursuit for educated and cultivated men, and this approach to the art has been continued in Sendai by a succession of distinguished amateurs. A famous bonsai connoisseur early in this century was Nobukana Kajiya, a railroad executive who admired bonsai grown from seed. He believed that these are the only true bonsai, and he became an almost violent advocate of this point of view in Japanese bonsai circles. Another skillful amateur of the same period, Misuke Tanzawa, was a college president, and two Sendai judges became prominent bonsai growers. Today many fine bonsai trained by these men are seen on the shelves of connoisseurs in Sendai.

The trident maple (*Acer buergerianum*) shown at the right was grown from a seed planted in 1879 by another outstanding amateur, Makoto Matsukura, the first major of Sendai. He and his son, who helped him train it, presented it to me about twenty-five years ago. A splendid healthy tree, it is known for its shapely leaves in spring and deep crimson color in autumn. The following bonsai techniques are the ones I have found best to keep it healthy and preserve its beauty.

Every spring before the buds open, I transplant the tree, removing it from the container and reducing the size of the ball of soil at the same time that I cut back the roots. I cover the drain holes of the container with fine screening, spread a thin layer of coarse sand for good drainage, and put down a layer of compost prepared with 3 parts of sand to 7 parts of a red and black clay-loam mixture. Then I place the tree in the container and tamp more compost around it, taking care that the roots everywhere come in contact with the soil. For ten days

Trident maple started from seed in 1879

*Left to right:* Needle-leaved juniper *(Juniperus rigida)*, 250 years old, in the author's collection; young specimen of *Magnolia kobus* in flower; Japanese red pine *(Pinus densiflora)* bonsai owned by author.

after this, the tree stays in shade, and after two weeks I give it fertilizer.

In early summer I pinch all the leaves off the tree, and smaller new leaves, lovely as emeralds, come out to replace them. (This technique, incidentally, can also be used with hornbeams, zelkovas, ginkgo and a few other deciduous trees. Removal of all their leaves not only results in a second crop of smaller leaves and stimulates brighter autumn color, but with younger trees, it hastens their development as bonsai. All leaves must never be removed from conifers, however; instead, their young sprouts are simply pinched back—as on page 53).

When the maple bonsai given me by the Matsukuras drops its leaves in late autumn, I bring it into the house for appreciation as frequently as I can without interrupting its dormancy. To me, the real beauty of deciduous trees is in the naked state of their winter-bare branches. One of the privileges we have as bonsai growers is that we can experience the great transitions of nature through seasonal changes in the miniature trees which are so close to us.

In Sendai we are fortunate in the natural beauty of our scenery. Sendai Bay, with its hundreds of islets, has been famous since olden times as one of the three loveliest landscapes in Japan. The pines growing on these islets are 'Aiguromatsu', a natural hybrid between Japanese black pine (*Pinus thunbergi*) and Japanese red pine (*Pinus densiflora*), and they are famous both as picturesque full-sized trees and as bonsai. In the mountains around Sendai, we can collect Japanese white pine (*Pinus parviflora*) on the high slopes of Mounts Zo-o and Azuma, and in the lower mountain ranges we find trees such as cryptomeria, zelkova, and Sargent and needle junipers to transplant and train as bonsai. No matter whether they have chosen to grow bonsai from collected wild trees, from seeds, or from cuttings, the bonsai amateurs of Sendai have been inspired in their art by nature's majestic ocean and mountain scenes. ✦

# WHERE BONSAI GET THEIR START

*A typical bonsai-raising center*

FOR bonsai-minded visitors to Japan, Omiya's Bonsai Village is the most refined bonsai center of all Japan. It is there that the finest bonsai may be seen in commercial nurseries. It is a "must" place for bonsai fanciers. It may be called the bonsai showcase of Japan. But do not forget that bonsai must be raised from little plants, so visitors to Japan should also see one or more of the larger bonsai-raising centers that are scattered from the south to the north of Japan. In such centers, often in villages or suburban towns, numerous bonsai-raising families have been engaged in the specialized effort of raising bonsai from seedlings and cuttings. Their work extends to the trimming and training of bonsai. Many of these families live in Kurume City and suburbs in northern Kyushu, in Nagoya and vicinity, in Niigata in northwest Japan, and other areas—including Kinashi. Here, I tell briefly of Kinashi Village, now incorporated in the City of Takamatsu, where it is situated in the Seto Inland Sea National Park.

The history of raising bonsai in Kinashi goes back some three centuries, as it does also for most other large bonsai-raising centers. There are now no less than 200 bonsai-raising families in the Kinashi area, working exclusively on bonsai culture. Kinashi is renowned for Japanese black pine and white pine bonsai. If you were to walk around on a footpath between the rice fields you would find many nursery fields, not only like the one of Japanese white pine shown in the photograph on page 84, but other fields with tens of thousands of Japanese white pine, one to several years old, grafted on Japanese black pine stocks. Footpaths extend for several tens of miles, and once I felt very sorry for members of the Brooklyn Botanic Garden staff who had come to visit the nurseries. They walked until they were exhausted.

Bonsai benches (as in the photograph) are seen everywhere in the front yards of bonsai-raisers' homes. They hold rows of Japanese black pines or white pines 10 to 100 years old, collected from their natural habitats, then greatly reduced in size by pruning. Such trees are handled in numbers throughout the village. To observe them in the different stages of their training never fails to arouse the interest of a visitor.—K.Y. ✦

Japanese white pine bonsai on benches—a familiar sight throughout Kinashi, where 200 families devote themselves to growing pine bonsai

*Yashiroda*

# OMIYA: BONSAI SHOWCASE

*A village of bonsai nurseries*

IN Bonsai Village in Omiya, Saitama Prefecture, Japan, there are two natural stone monuments. Both were erected in 1935 on the occasion of the tenth anniversary of the founding of this "bonsai town." Through their inscriptions they celebrate the achievements of the founder and his cooperators.

Engraved on one monument are two Chinese characters which represent the winning of immortal fame. The other bears an inscription telling how Bonsai Village was founded and how it also prospered. It relates how Mr. Shimizu, whose name had been Ritaro (proprietor of the Shimizu-en bonsai nursery), bonsai-man by trade, had prospered in Tokyo. As the Tokyo environs became unfavorable for bonsai growing after the earthquake and fires of 1923, Mr. Shimizu sought a new location that would be suitable in every way. He finally found such a place in the town of Omiya and moved there in March of 1925. He worked assiduously for years and with the cooperation and help of R. Suzuki, Tomekichi (the father of Mr. Saburo Kato whose contribution appears elsewhere in this Handbook) and Katsuzo Nishimura, the bonsai town has prospered ever since.

No visitor to Japan should fail to visit Bonsai Village in Omiya. It is only one hour by rail from downtown Tokyo.—K.Y. ✦

*Yashiroda*

Huge natural stone monument that commemorates the founding of the Bonsai Village of Omiya

One of Japan's fine bonsai nurseries

*Yoshimura*

# CASCADES

"Cascade style has developed from the forms taken by trees hanging from a cliff. Just as these must be deep-rooted to withstand wind and storm, so a cascade is planted in a deeper container than most bonsai to anchor it and balance the composition."

—*Zeko Nakamura*

Illustrations by Frank Okamura

A cascade bonsai is one in which the main trunk and branches are trained to grow down over the edge of the container, giving the feeling of a tree jutting from a rocky ledge. A fine bonsai in this style usually has a sinuous, winding trunk which suggests the storm-tossed existence of its prototype. Its "clouds" or foliage masses cluster around the trunk's outward bends. On the cascade's viewing side, a branch is often trained to grow partly across the front of the tall container in order to break the line.

As for plants to use in cascade training, many small-leaved species that are appropriate for upright styles also make pleasing cascades. One tree which lends itself to quick results is the weeping willow, whose flexible branches are easily wired into almost any position. Frequent pinching of the new shoots and well-timed fertilizing should produce an attractive plant within one or two growing seasons. Weeping willows grow so rapidly, however, that they require frequent re-training to keep them graceful and in scale; and for this reason they cannot be used to make bonsai of distinction.

The traditional bonsai species—particularly small-leaved azaleas, junipers, and certain flowering and fruiting trees—are the best material for fine cascades. An attractive miniature cascade can be created with the Tom Thumb variety of rockspray (*Cotoneaster horizontalis*).

A tree which is to be trained as a cascade is usually planted at a slant in its container. Guy wires (page 68), fixed rather loosely at first and then tightened every few weeks, are often the initial training method used for bending the trunk downward past the container's edge. The serpentine curves into which the trunk is then trained are produced by traditional wiring techniques (page 66). The masses of foliage which should grow at outward bends of the trunk are created by frequent pinching of the new shoots to encourage profuse branching at these points. ✦

# THE PLEASURES OF COLOR

## *A link with the seasons*

**George F. Hull**

ONE quality of bonsai that is often overlooked is color. We are likely to remember as an outstanding example of bonsai some weather-beaten juniper or twisted pine, an image in the mind of line and mass etched only in black and white. But this idea of monochrome can sometimes be carried too far. Color is part of nature, and it is in the area of color that I think many amateurs will find some of the early pleasures on the path toward bonsai. A few examples of colorful plants that have been grown by hobbyists in this country will indicate some of the possibilities.

One is flowering quince, a common shrub adapted to most areas, which is popular because its beautiful flowers stud the bare branches early in the year. Although old specimens respond well to drastic pruning of both top and roots, the quicker route to a flowering bonsai is to select a younger one with interesting branch structure from the wide assortment of container-grown plants offered by nurserymen. The dwarf Japanese

*Pulitzer*

Seasonal bonsai: Oak tree (*Quercus dentata*), now well over a century old, photographed in late winter, then in spring, its true display season—with flowering catkins and unfolding leaves. In summer, leaves of this species are too large for good bonsai scale; in winter, the bare branches lack bonsai quality. Collections often contain many "seasonal" bonsai which are placed on view for a short time every year. This tree was presented to the Brooklyn Botanic Garden by the late Ernest F. Coe in 1925.

quince (*Chaenomeles japonica* in variety) is one of several kinds that often assume picturesque branching when quite small. In late winter such a plant may be repotted into something more attractive than the nursery pot, the root ball made more shallow for better proportions, excess and crossing branches pruned away and, perhaps, one or two wired to a different position for better composition. The plant is ready for an early spring show. As soon as buds indicate the start of growth, the plant should be brought to a cool place indoors and kept watered. After flowering, keep the plant in good light and away from hard frost until spring weather has moderated to the point where it is safe to put it outdoors.

Developing an azalea of real bonsai stature might require a long search for a suitable old plant, and some skill and time in adapting it to the right container. On the other hand, enjoyment of azaleas in bloom can be immediate, even if their training as bonsai has just begun. Japanese connoisseurs grow some varieties of azaleas that remain models of restraint for eleven months of the year, then don a Mardi Gras cloak of brilliant color. For bloom in the true bonsai tradition, varieties with small flowers are appropriate. Azaleas by nature have shallow, compact root systems that permit safe transplanting even when they are in bloom, if reasonable care is exercised. In some climate zones, brilliant early-flowering azaleas can prove to be more rewarding as potted plants than when growing in the garden. At our home, where spring weather often produces rapid changes from hot sun to driving rain to frost during some seasons outdoors, the early azaleas may prove to be attractive five days or fewer. Indoors we regularly expect to enjoy the potted ones for five weeks.

Japanese maples are another example of a species whose color may be quickly enjoyed in a container. These are very slow-growing trees that take a long time to achieve enough size in the garden to make them effective, unless a very high price is paid for an old specimen. Small container plants, on the other hand, can be displayed so their beauty may be seen at close range and enjoyed despite their size. Even young nursery plants, especially some of the thread- or fern-leaf varieties (*Acer palmatum dissectum*) may be found that have developed picturesque forms. Spring foliage is colorful; some kinds remain red all summer, and most of them turn to beautiful shades of yellow, orange, and scarlet in autumn in climates where they are adapted.

A little plant hunting among the tropical or subtropical species can be productive of colorful plants. One that I have seen well grown is pistachio (not the one that produces the edible nuts, but a Chinese relative sometimes grown in California and other mild climates). The compound leaves turn brilliant orange and red before they drop. Malpighia is a tender evergreen shrub with tiny holly-like leaves used in Florida gardens, sometimes as a hedge. Older pot plants soon develop interesting trunks and exposed-root systems.

Traditional bonsai also offer color interest throughout the seasons, especially effective because of the close view such plants make possible. At this intimate approach we see the tiny bundles of yellow-green leaves on larch, the "candles" of new growth on pine, the winged fuits of maple. Many common trees have lovely flowers that are overlooked on large specimens. How often do we enjoy the beauty of flowers and budding leaves on oak trees?

Some of the plants mentioned here will never achieve the treelike proportions of venerable bonsai, but I believe their inclusion in American collections, for those who find them attractive, is justified in the same way that expert Japanese fanciers often show their sentimental attachment to some ornamental species, such as the fragrant fingered citron (*Citrus medica sarcodactylus*) or specimens of *Rohdea*. ✦

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From *Bonsai for Americans*, by George F. Hull. Copyright © 1964 by George F. Hull. Reprinted by permission of Doubleday & Company, Inc.

# BONSAI
## the ancient art

Trees that grow in the rocky crevices of high mountains may live for a century or more, yet remain dwarfed throughout their existence. Windblown and often gnarled and twisted, their weather-buffeted appearance captures our interest and respect just as it caught the fancy of the Japanese long ago when the culture of dwarfed potted trees first became a living art. Grown in appropriate containers, such trees have esthetic appeal. Pictured here are many of the classic bonsai in the Botanic Garden Collections.

CHINESE JUNIPER *(Juniperus chinensis sargenti)*. Height 19 inches above container. Over 150 years old. A naturally gnarled tree from the mountains of Japan with only a narrow strip of live bark. Trained for many years, and imported from the nursery of Kyuzo Murata in 1961. *Phipps Collection.*

AZALEA *(Rhododendron indicum)* in springtime. Flowers are normal size, actually too large for this dwarfed tree. Height 18 inches above container; age about a half century. Imported from Kyuzo Murata. *Phipps Collection.*

CHINESE HACKBERRY *(Celtis sinensis)* with spring foliage. Height above container 25 inches. Age about 50 years when imported from Kyuzo Murata in 1961. It was raised from a seedling and had been in training about 30 years. *Holsten Collection.*

TRIDENT MAPLE *(Acer buergerianum)* in spring and summer. Gift of the City of Tokyo to City of New York, 1961, courtesy of Mr. Yasujiro Tsutsumi. Height above container 28 inches. Age 84 years when imported from Kyuzo Murata. *(Front & Back Views)*

## SIZE AND SEASON

Growing miniature bonsai can be an art all its own, but miniatures may also be a starting point for larger bonsai. Carefully selected cuttings, rooted in a few weeks and transplanted to appropriate tiny containers, will become respectable little bonsai in a single growing season. They may be kept small, or, if grown on into larger bonsai, they will provide beauty and pleasure every step of the way.

Trunks that are plump at the base and tapering toward the top give quality to a bonsai specimen. Small-leaved species make the best bonsai. This explains why Chinese juniper is a favorite, also the short-needled Japanese white pine. Azaleas, Japanese holly and small-leaved maples are also esteemed in the bonsai homeland. By cultural techniques it is possible to induce the development of smaller leaves, but not so with flowers and fruits. Thus the importance of selecting kinds with naturally small flowers and fruits, so that all parts of the tree are in the proper diminutive scale.

Some bonsai, such as those grown for their flowers, have only seasonal beauty; they bloom for merely a week or so each spring. In contrast the pines, junipers and other fine-textured evergreens offer a certain restrained beauty and naturalness every day of the year.

AZALEA *(Rhododendron indicum)*. Roots clasp the rock and grow into the soil below. Height above container 17 inches, age about 60 years. Imported in 1957 from the Yoshimura Nursery, Tokyo. *Phipps Collection.*

MINIATURE BONSA
tanic Garden by Frank
height 3 to 6 inches abo
Left to right, Arizona
Retinospora *(Chamaecy*
trate Juniper *(Juniperus*
Holly *(Ilex Crenata)*, H
*obtusa)*. Age 3 to 12 ye

ATLAS CEDAR *(Cedrus atlantica glauca)*. Height 21 inches above container, age 18 years. Trained by Frank Okamura of the Brooklyn Botanic Garden. *Holsten Collection.*

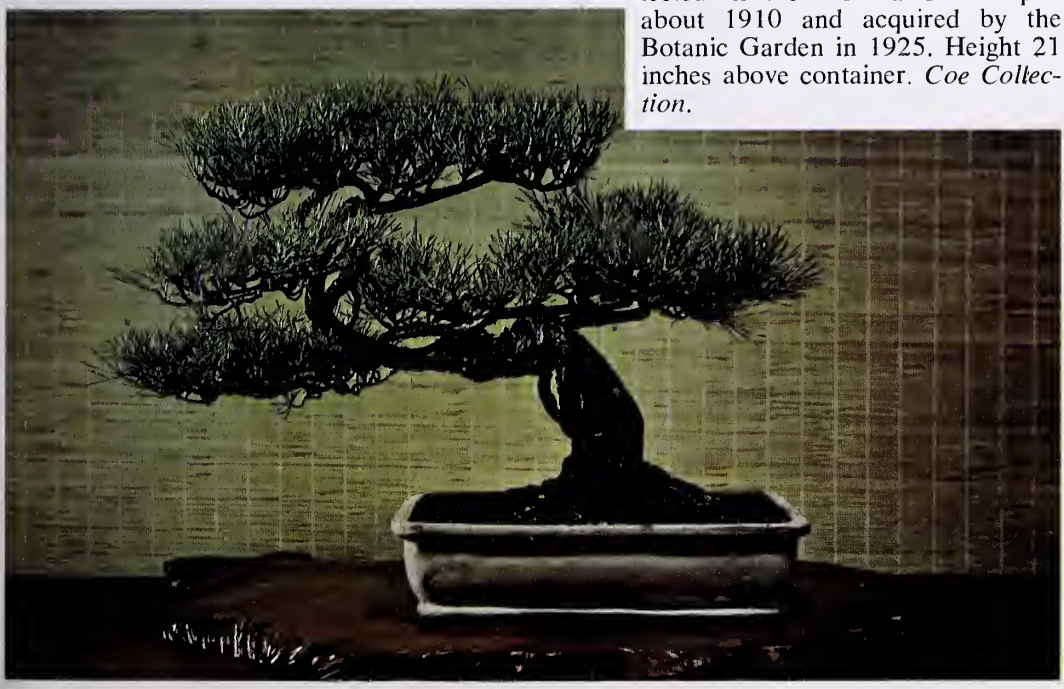
FIRETHORN *(Pyracantha coccinea)* in autumn. Age 7 years, but only 2 years in training by Frank Okamura. Height 11 inches above container. *Holsten Collection.*

ted at the Brooklyn Bo-
nura and Kan Yashiroda;
ntainers.

ss *(Cupressus arizonica),*
*pisifera squarrosa),* Pros-
*mata prostrata),* Japanese
Cypress *(Chamaecyparis*

SARGENT JUNIPER *(Juniperus chinensis sargenti).* Height 17 inches above container. From a natural tree, age about 100 years. *Holsten Collection.*

JAPANESE RED PINE *(Pinus densiflora).* Over a century old. Collected in the mountains of Japan about 1910 and acquired by the Botanic Garden in 1925. Height 21 inches above container. *Coe Collection.*



JAPANESE WHITE PINE *(Pinus parviflora)* with forked trunk. Height 21 inches above container. Age about 65 years. Imported in 1957 from the Yoshimura Nursery, Tokyo. *Phipps Collection.*

## THE CLASSIC PINES

To the Japanese, pine trees are symbols of long life. They increase in dignity with age. The Japanese white pine *(Pinus parviflora)* is admirably suited to bonsai culture, particularly the short-needled varieties. Kyuzo Murata points out that the Japanese white pine is a "hardy tree that will live for hundreds of years in a container. The growth is slow, but the trunk becomes thick and the branches numerous." Pinching and/or bud removal in spring makes needle length, size and shape control relatively easy of accomplishment. And the several styles illustrated here (container, rock and slab-grown) show that the tree lends itself to great versatility of culture.

JAPANESE WHITE PINE *(Pinus parviflora).* This collected wild tree, planted on a rock, is about 75 years old. Imported in 1964 from the nursery of Kyuzo Murata. Overall height 21 inches. *Phipps Collection.* →

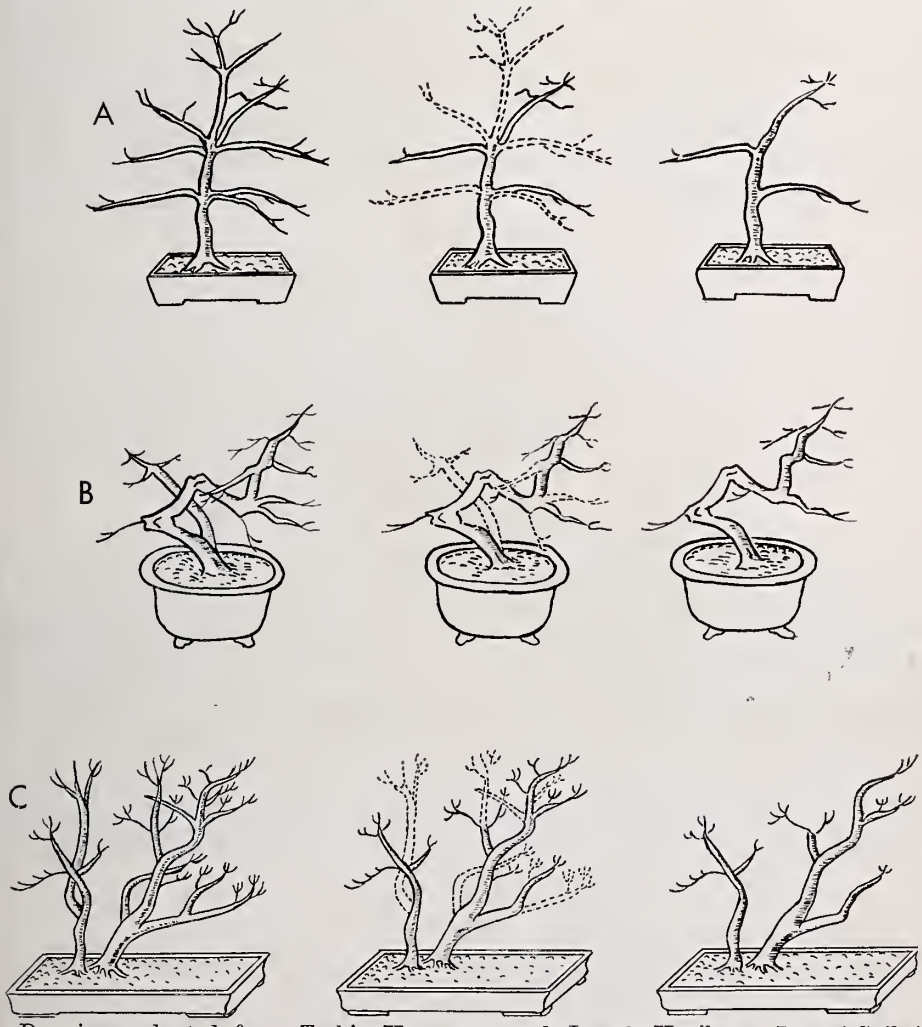
JAPANESE WHITE PINE *(Pinus parviflora)*. A famous bonsai in Japan before it was imported in 1961 from the nursery of Kyuzo Murata. Trained from a single tree to give the appearance of a forest grove. Height 27 inches above the granite slab on which it grows; age about 40 years. Trunks all connect at base. *Holsten Collection.*

JAPANESE WHITE PINE *(Pinus parviflora)*, between 200 and 300 years of age. This naturally dwarfed tree was originally found in the mountains of Shikoku Island, Japan. Imported in 1964 from the nursery of Kyuzo Murata. Height 28 inches above container. *Phipps Collection.*

# PRUNING FOR BASIC FORM

IN training bonsai from nursery-grown trees, it is important to remove all but the key branches. These will form the simplified skeleton of the bonsai-to-be, since it is from these limbs that new leaves and new shoots will grow. Foliage masses can be created around each branch if new shoots are pinched back as they develop.

In pruning the five-year-old tree **A**, only one branch is allowed to remain at each level. This avoids the oversymmetrical effect of opposite branches, creates a feeling of openness between branches and accentuates the diminutive trunk. Tree **B**, a distorted specimen such as can occasionally be found in a nursery or growing wild, is pruned mainly to simplify the branch structure and emphasize its asymmetrical trunk. The trees in **C** are a kind one is sometimes fortunate enough to discover: specimens with interesting branch patterns, selectively pruned, are immediately attractive as bonsai. ✦




—Drawings adapted from Toshio Kawamoto and Joseph Kurihara, *Bonsai-Saikei.*

# PINCHING BACK NEW GROWTH

*Buhle*

Flowering quince *(Chaenomeles japonica)* before and after pinching. Before, bonsai character is lost as leggy new shoots develop on this five-year-old plant. After pinching, bonsai shape and scale are re-established. Pinching keeps a tree small: leggy growth is removed, thicker foliage masses develop, and a denser crown results. Note that the word "pinching" is used here to cover all trimming procedures, whether with clippers, scissors or fingers. For details on pinching different species, see pages 52 and 53.

*Buhle*

Japanese winterberry *(Ilex serrata)* before and after pinching. A well-groomed bonsai is kept pinched and thinned. Repeated pinching arrests overall growth: A bonsai which has been pinched regularly for years shows little increase in size, and the new shoots have short internodes. Thus, constant pinching keeps a tree dwarfed.

POMEGRANATE BEFORE AND AFTER PINCHING

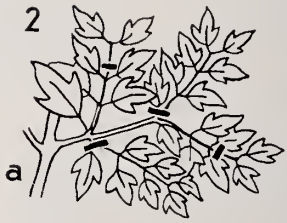
*Buhle*

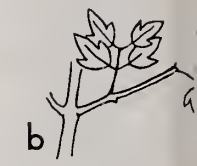
This seventy-year-old *Punica granatum,* long established as a bonsai, must be groomed frequently during the growing season.

# PINCHING TECHNIQUES

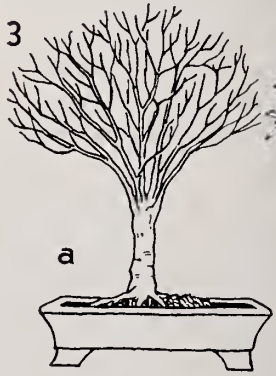
### For Deciduous Trees

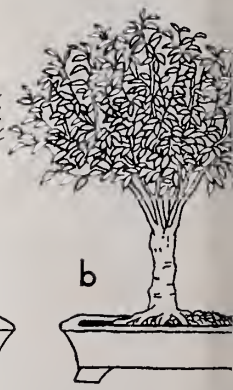
BEGINNING in early spring, pinch back throughout growing season. When a tree is growing vigorously, frequent pinching gives best results. In general, allow as many as five new leaves to develop on a young branch; then pinch back to the first one or two at top of tree, and the first three or four elsewhere (see drawing **1**).




Choose a side bud that points in the direction you want a branch to grow, and pinch just above it. If buds grow in pairs, one of each pair should be removed to give plant a more asymmetrical appearance. Likewise remove alternate shoots, as in **2a** and **b.**



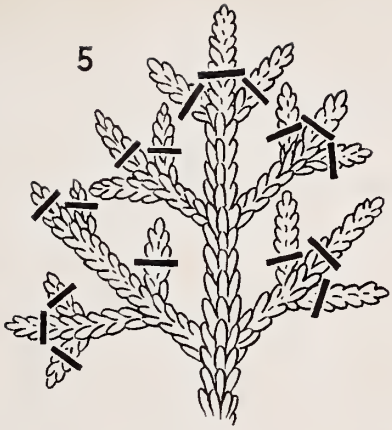

With healthy deciduous trees of some species, such as maple and zelkova, all the foliage can be nipped off in early summer, so that tree is completely bare (**3a**). A new crop of leaves, daintier in size and more decorative, will develop in a week or so (**3b**). See page 35 for Makoto Inawashiro's description of this procedure. Caution: Total leaf stripping is never practiced with needled evergreens.

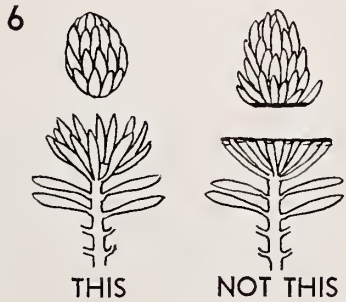
### For Flowering Trees and Fruit Trees

With flowering and fruiting trees, pinching is timed differently for different species so that incipient flower buds will be left intact. Azaleas, for example, should be pinched severely just after flowering. Of the five new shoots (**4a**) which usually appear, only one or two should be retained, and these should be cut back to two or three leaves (**4b**). Later in growing season, azaleas are pinched more sparingly so that some flower buds will form.

### For Evergreens such as Juniper and Cryptomeria

With evergreens which produce new shoots throughout growing season, pinch off a few tips more or less daily while tree continues to send forth new growth. For scale-leaved juniper, gradually remove tips, as shown in **5**. When pinching species with needled leaves (as in **6**), be careful not to cut through needles which are left on tree, for remaining stumps will turn brown.



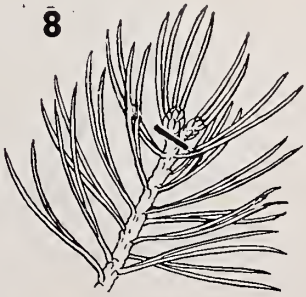




### For Evergreens such as Pines, Spruces and Firs

With evergreens whose main growth occurs in spring, pinch young shoots at that season by removing half or more of each just as individual needles begin to show. Drawing **7** illustrates pinching of pine "candles." See also Saburo Kato's description of pinching spruce (page 74).

### Disbudding Pines

If needles of a pine bonsai become too long in relation to size of tree, all buds can be removed (as shown in **8**) approximately every third spring. The plant's appearance may be poor for a season, but the new buds and the needles that come from them the following season will be much smaller. This method is used to maintain compact foliage of white pine bonsai shown on pages 46 and 47. ✦



# BONSAI MINIATURES

*How a busy actor looks after his collection of 1,000*

Zeko Nakamura

A finished bonsai is the result of long years of endurance and patience in caring for it and training it to grow in a container. Unlike a plant living in a garden or growing wild, its daily watering cannot be neglected. I am very busy working in the theater, movies and TV, but I manage to find time for watering my collection of miniature bonsai, and I do all the transplanting and training myself. When I have to be away from home all day, which happens often, my whole family is willing to help with the watering, as shown in the photograph on the next page.

Japanese actor Zeko Nakamura with some of his miniature bonsai. Few in his collection are over 4 inches high.

Miniature bonsai are so small that they must be watered an average of three times a day, and five to seven times a day in summer. Also, each watering involves wetting the plants three times: the first soaks only the surface soil, the second penetrates to the middle of the containers, and the third wets all the soil so that surplus water runs out of the bottom holes. This incessant watering is the major drawback to miniature bonsai, an annoyance not only to the beginner but also to many connoisseurs. Beginners are likely to scant it and consequently to have their plants die.

One of the great advantages of miniatures, on the other hand, is the small amount of space they occupy. Provided that it is sunny or only lightly shaded, a shelf or area about 3 by 7 feet is space enough to grow 100 to 200 plants. As I described in the Botanic Garden's first handbook on bonsai, for many years I kept a collection of about 400 on a shelf built on the roof of my house. Since then I have moved to a house with a small garden and have increased the number to 1,000. They now include almost all the Japanese woody plants that can be made into bonsai.

Nearly all my miniatures are 4 inches high or less; but even so, the crab apple, orange, pomegranate, peach, apricot, quince and chestnut trees bear fruit for me. The whole of last winter, for example, I enjoyed a 4-inch crab apple bonsai hung with twenty-five scarlet apples. My only failure in fruit has been with Japanese persimmon, which, since it bears fruit as a regular-sized bonsai, I assume needs more root space than miniature containers provide.

Of the flowering trees, my collection is so varied that there is no month without flowers in my garden. Probably the most spectacular are 80 miniature Japa-

nese cherries in a variety called 'Kyokuzan'. In the spring every plant is smothered with full-sized flowers, actually too big for 4-inch trees. Last year I displayed some on a television program which featured Miss Cherry Blossom, who was visiting Japan from the United States. The response was almost too enthusiastic, as a large number of feminine televiewers then rushed to my house.

The person who wishes to learn how to raise miniature bonsai needs to know the common techniques for planting and taking care of them, together with some general principles of style and form used in their training. For miniatures, however, the maxim "Learn from the tree" is the main point about style: you need not be a slave to the rules. I myself interpret the traditional forms with considerable freedom, and the naturalness of my miniature bonsai was much praised in a three-man show I once gave together with a flower arranger and a ceramic artist.

My advice to the novice is to start by growing herbaceous plants in small containers, in order to get practical experience while using moderate-priced materials. I think the best way of all to begin is by attempting to dwarf wild flowers —dandelions, gentians, asters or any tiny small-flowered plants that are available in your locality. Besides helping you master the technical difficulties of miniature bonsai culture, these will give pleas-

When Mr. Nakamura is away from home, his family takes over the task of watering. Miniature bonsai must be watered on average of three times a day, and five to seven times a day in summer.

ure in themselves when they flower for you. As the grower acquires experience, in one way and another he will cause the death of many plants; but this everyone must accept, since it is inevitable in the course of learning how to grow bonsai.

Although I am no botanist, in the course of forty years' work with plants I have become more skillful in my hobby of miniature bonsai than in my profession as an actor. This is perhaps unfortunate for the profession, but good for the plants. Here are some suggestions out of my own bonsai experience that may save others from making mistakes.

***Watering.*** In spring and fall I water two or three times a day; in summer five times as a rule, but seven times on windy days. Winter winds in Tokyo are so drying that I put the bonsai in a coldframe, where they need water only once a day or every other day, provided I am careful about particular plants which dry out faster than the rest. Since the soil often freezes at night during midwinter, I water after ten in the morning, and never in the evening.

As described earlier, each of these waterings involves wetting the soil three times. Here in Tokyo, city water direct from the tap is irritating to the plants, so I put it in a large jar and let it stand before using.

***Sun.*** As long as they are watered copiously, my miniatures do best when kept in full sun, even at midday. Those grown in the shade tend to be delicate, and their flowers are paler. For example, when a red-flowered plant is brought indoors for a week before it blooms, the flowers open pale pink or white.

Sunshine is good for people as well as for plants. Watering my bonsai has kept me in the sun so much that I am burnt almost black. I think this may be the reason I have not been ill in the past forty years.

***Soil.*** The kind of soil used for miniature bonsai is of the greatest importance; yet it is also a highly individual matter. I take the red or blackish clay with no organic content which is dug from deep underground, expose it to the sun for a week, and then sterilize and sieve it. However, miniature bonsai grow equally well in fine loam soil. The beginner should try out various soils; no better teacher than experience.

***Transplanting.*** All potted plants become sick of their soil after a while, especially miniatures, which are growing in two or three spoonfuls. I repot most of mine annually, trimming one-third of the roots each time. Even pines, which are transplanted and root-pruned only about once in ten years when they are regular bonsai, require it every five years as miniatures.

Generally speaking, transplanting is done in the early spring just before the buds open. It is time to begin work when temperatures during the day average about 60 degrees. The procedure is the same as with regular bonsai, although for miniatures it is especially important to provide good drainage and to use screening over the bottom holes so that the soil will not be washed away.

Like a man just out of the hospital, the transplanted bonsai need careful treatment. The leaves of broad-leaved trees should be cut in half to reduce demands on the newly trimmed root system. The foliage of all varieties should be syringed daily, and protection should be given from sun and wind for a week before the trees are gradually moved back into the sun.

***Fertilizing.*** My recommendation is to be very sparing with fertilizer. Miniature bonsai are so small that they are easy to overfertilize, and this is often fatal to them. If necessary, they can utilize the nutrients already in the soil and grow normally for a year or so without fertilizer.

I use liquid fertilizers which are so highly diluted that the plants have no unpleasant smell when they are handled or brought indoors for appreciation. These liquids should be poured on only after watering. As for the best seasons to apply fertilizer, I begin in the late spring

In the garden: Mr. Nakamura and his family holding some of his flowering miniatures. His son is 22 years old, his wife 63, his mother 92, his daughter 25, and the author himself 65. Plants and family alike are in good health, says Mr. Nakamura.

and continue weekly through the summer. During rainy periods, however, I stop using it, and I apply it only occasionally in winter. This schedule keeps the bonsai healthy at the same time that it helps in the dwarfing process. Growth is naturally vigorous in early spring and during rainy spells, and fertilizing then will simply overstimulate the plants.

Overfertilizing often causes the leaves to turn yellow or white, and to shrivel and die if it is severe enough. Japanese white pine is especially susceptible to this kind of damage.

***Disinfection.*** Nowadays many kinds of gardening sprays are on the market. Follow the manufacturer's directions carefully, and spray the plants two or three times a month, including the undersides of the leaves. Use an old toothbrush to wash the trunks with the chemical, as insects, often invisible, may be embedded in the bark.

My favorite homemade spray is composed of cigarette butts steeped in water to which soap is added. The diluted liquid is effective for the less stubborn insects, and it is milder for the plants than garden sprays sometimes are.

***Training.*** Although the trunk and a few main branches of miniature bonsai are sometimes shaped with wire, by far the largest part of their training consists of scissors training. These plants are too small for much wiring, and it is better to be patient even though it takes more

years—an average of ten, I would say—to produce a well-trained bonsai. Actually, I find scissors training so interesting that it is one of my chief pleasures in growing miniature bonsai.

There are a few other techniques I use in training miniatures. For example, it is my impression that broom-style *Zelkova serrata* develop more quickly if their branches are softly smoothed upward by hand whenever one has the time. Also, a trunk can be thickened artificially by "exercising" it several times a week—that is, by holding it at the bottom with one hand while bending it from side to side with the other. The resulting separation of the bark from the woody part causes a kind of "inflammation" which leads to thickening. Be careful, however; too-violent exercise can kill a tree.

***Miniature Forests.*** As I said earlier, there is no need to follow traditional styles rigidly with miniature bonsai; often a design that is free and artless looks better than one shaped according to formula. As an example, here is a suggestion for creating a miniature forest without observing the rules and restrictions which make it such a difficult art in bonsai design: Pick up a handful of small trees at random, set the whole handful down in a container, plant them wherever they happen to lie, and then rearrange some trunks or branches slightly with tweezers. Such an offhand arrangement sometimes has a naturalness and simplicity that cannot be duplicated by artifice. If, on the other hand, you wish to follow a ground plan in making a miniature forest, try the design I have sketched in drawing **1** (page 60). Notice that the container should be shallow and open; the secret is to leave space within it in order to suggest the sweep of a natural landscape.

Three-trunked Japanese white pine *(Pinus parviflora)* in Mr. Nakamura's collection. At its tallest point, 5 inches.

Needle juniper *(Juniperus rigida)* owned by Mr. Nakamura: 25 years old, 4½ inches high.

***Stone-Clasping Miniatures.*** As shown in drawing **2**, I make this kind of planting by placing a miniature tree into sticky clay which I have smeared in the hollow of a stone. The tree can be anchored into position with wires which have already been fixed to the rock, as in the first sketch of the drawing (see Seizan Ito's instructions for attaching wires to a stone, page 20). This kind of planting is not exposed immediately to full sun; the tree takes a while to become established on the rock and should be kept in a shady spot protected from wind.

***Cascades.*** Cascade style has developed from the forms taken by trees hanging from a cliff. Just as these must be deep-rooted to withstand wind and storm,

Miniature forest bonsai of Ezo spruce *(Picea jezoensis)*, trained 12 years from cuttings. The highest is under 3 inches.

so a cascade is planted in a deeper container than most bonsai to anchor it and balance the composition. Cascading miniatures are started with well-grown trees that are two or three years old. Before wiring a tree, I sketch several possible cascade designs and choose the best among them. Don't change your mind about the shape after you have wired a cascade; beginning over again will only damage the tree.

***Sources of Plants.*** Like regular bonsai, miniatures can be grown from cuttings or seeds, can be collected as wild plants and can be propagated by air layering.

I take cuttings from a plant by slicing off small branches, using a sharp knife and making slanting cuts. I remove the tips of these slanting ends, as shown in drawing 3, and insert the cuttings deeply at a slant into a suitable rooting medium which contains no fertilizer. I water them copiously, set them in semi-shade out of the wind and spray the leaves from time to time. I find that early spring when the buds are bursting is the best season for growing cuttings. It seems as

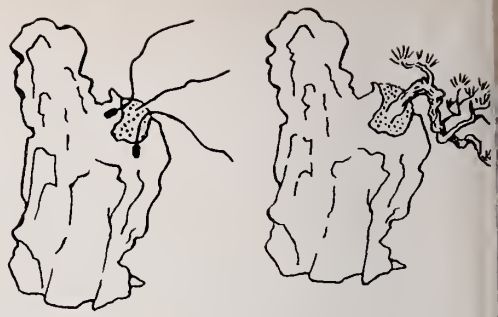
Japanese black pine *(Pinus thunbergi)* between 80 and 100 years old. Its height is 6 inches, which makes it one of the tallest among Mr. Nakamura's miniatures.

if almost everything except bamboo can be propagated by this method; many growers even use it to raise pines.

To grow miniature bonsai from seeds, I sow the seeds in early spring in the same kind of soil used for cuttings. I keep the seedlings in flats for a year, occasionally giving them weak fertilizer, and transplant them to single containers in the second year.

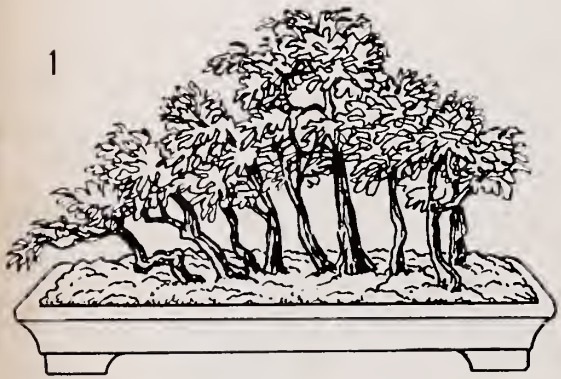
Of wild plants collected from the mountains, four- and five-year-old seedlings are best for training as miniatures. Most of my bonsai shown in the photographs are plants I collected when on location making movies. After I find a suitable small plant, I dig it up carefully, trying not to damage any fibrous roots but removing the taproot. I leave some soil attached to the roots, wrap them in moistened moss or newspaper and carry the trees home in plastic bags. For the first year I plant them in a larger pot than the usual bonsai container. Although collecting is most successful in the spring when the wild trees are just beginning to sprout, they can also be dug up at other times of the year, especially if one takes them home with a fair amount of soil attached to the roots and gives them extra care at first.

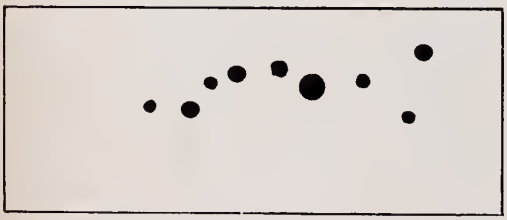
2



Planting a stone-clasping miniature in the hollow of a rock. Copper wires are attached to the stone, and the hollow is filled with soil. After the tree is planted, the wires are wrapped around it to anchor it securely. Then the soil and wires can be concealed with a layer of moss.

1





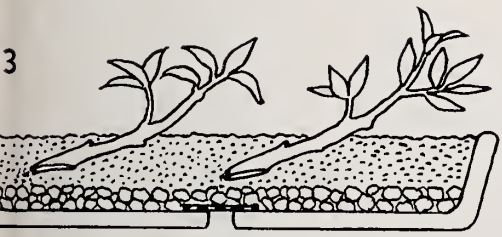
Ground plan for a miniature forest. The container should be shallow, and open space should be left around the trees to suggest the sweep of a natural landscape.

In air layering, a portion of a tree which is desirable to make into an independent bonsai is induced to root and is then removed. Early summer when the tree is growing most actively is the best time for this. As shown in drawing 4, the bark is removed over an area 2 to 2½ times the diameter of the branch, and the wound is covered with well-moistened sphagnum moss or fine soil, which is then bound in place with a sheet of plastic loosely fastened at the top for frequent watering. In a month and a half, new roots will have developed, and in two months the branch is ready to be cut off and planted separately.

Air layering is a well-known technique the world over, and varies in detail only according to the kind of plant that is being aerial-rooted. The pomegranate I have shown in drawing 4 illustrates a typical procedure for deciduous plants.

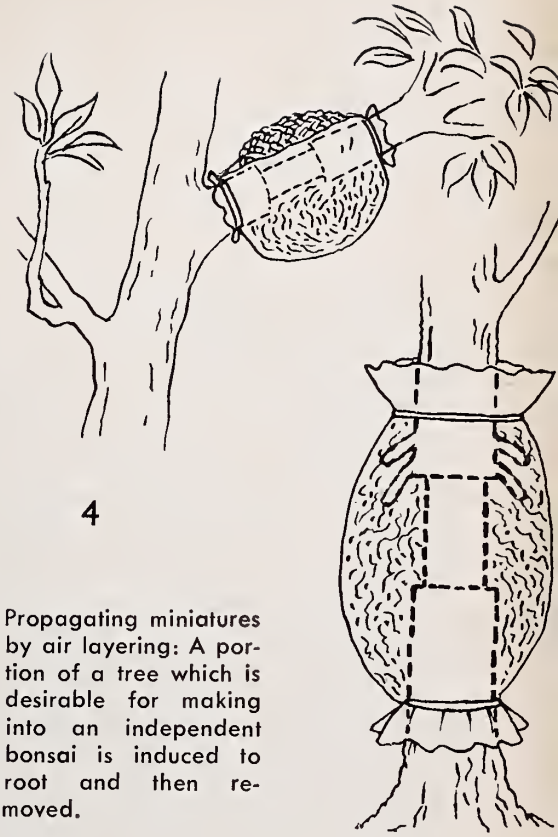
In closing, I should say that all my rules for taking care of miniature bonsai may not work for you. As every collector's plants become accustomed to the environment he provides, they develop different requirements. One person's miniature bonsai, for example, may do very well when watered only twice a day, another's may die if not watered six times. When you have mastered the principles behind the rules, you will know what your plants need, and they will repay your care by growing their best, bearing flowers in the spring and fruit in the fall and so giving you joy in return. ✦

3



Propagating miniatures from cuttings: Insert them deeply at a slant into a suitable rooting medium with good drainage.

4



Propagating miniatures by air layering: A portion of a tree which is desirable for making into an independent bonsai is induced to root and then removed.

# WATERING BONSAI

IN the spring, water evergreens and deciduous bonsai once each day, preferably in the morning.

In the summer, water bonsai two or three times each day depending on the amount of sunshine and wind as well as the depth of the container. Watch them carefully.

In the fall, on sunny days, water bonsai once a day, in the morning. During long periods of cloudy days, less water is required. Watch carefully, and when water is needed, give it in the morning.

In the winter, water once daily on sunny days, in the morning. Watch carefully during long periods of cloudy days, and when water is needed, give it in the morning.

The technique is this: Water from above with a spray that does not disturb the surface soil. Continue watering until water is dripping through the holes in the bottom of the container.

Another method for watering is to submerge the lower three-fourths of the container in a tub of water and allow it to remain there until the surface of the soil looks moist, or about 20 minutes. This requires a bit of labor if one's bonsai collection is large.

Frequently, the surface of the soil will appear to be moist, so it is best to scratch it with fingernails or a stick to determine the need for additional water. ✦

—From Lynn R. Perry, *Bonsai: Trees and Shrubs, A Guide to the Methods of Kyuzo Murata.* Copyright © 1964. The Ronald Press Company, New York.

# MY GARDEN IN YAWATA

*In the heart of an industrial region, bonsai are grown in gardens and on rooftops*

**Minoru Minashu**

The author in his garden

AS I awaken in the morning, my feet carry me almost without thought to the garden, where my beloved plants are awaiting me. Laden with morning dew and displaying the colors of the season, my bonsai are lined up on their shelves. The exquisitely small features of *Rhododendron kiusianum* are so charming that I stop some minutes to look at them. The strong exposed roots of a Japanese white pine appear more impressive every day. Each plant, though humble in quality, brings me pleasant memories of its training, and I pass the time with them forgetting things in everyday life.

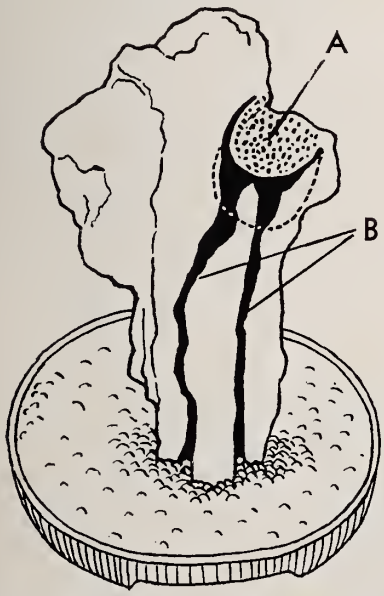
The streets of Yawata, where I live, are full of foul air, as there are so many factories. Yet by taking pains, many of us are able to grow bonsai perfectly. Some find space for their bonsai shelves on the rooftop of an apartment house, while others keep them in a small garden like mine.

Every bonsai grower in Yawata has his favorite type of plant for bonsai; mine is *R. kiusianum,* long a celebrated species in Japan, which is coming to have worldwide popularity. Also called Kirishima mountain azalea, it is native only to the high mountains of our southernmost Kyushu, one of the four main islands which make up Japan. When a specimen has been collected from the wilds, training is commonly begun by cutting it back

severely, often to the bare trunk. New shoots which then sprout are trained to form a thick new crown lower on the trunk than the old one. (See the photographs in the following article). Today, however, *R. kiusianum* is usually propagated from cuttings. Within three years after a cutting is rooted, it is 2 to 3 inches high and has begun to flower in the spring. Most blossoms of this dwarf azalea are various shades of pink, though some rare kinds have white flowers.

In training bonsai, I enjoy making cascades and stone-clasping plantings. To create a cascade I start with a plant such as the cotoneaster I have sketched in skeleton form in the first drawing above. I transfer it to a tall container and wire-train its trunk and branches into the curves shown in the second drawing at right. From its best viewing angle, a cascade should grow downward to one side or the other in order not to hide the container.

Cotoneaster before and after being shaped into a cascade bonsai.




For a stone-clasping bonsai: A cavity is chiseled in a soft pumice stone at *A*, and grooves *(B)* are scored down the face. *A* and *B* are lined with sticky soil, the tree is set into *A*, and its roots are led along grooves down to soil in the container.

For stone-clasping bonsai I often use pumice stone, since it is soft enough to work with a chisel or knife. By this means I make the bottom concave so that the planting will be completely stable. Then I chip a hole in the stone as shown at *A* of the drawing at left and score two grooves (*B*) down its face. I line the hole and grooves with sticky soil and set the tree in the hole, leading the roots along the grooves down to the soil in the container. Finally I cover the roots with sphagnum moss which I fasten to the rock with strings.

After I work for a time with my bonsai in the morning, I go to my job at the Yawata Ironworks, which employs 40,000 people. In my spare hours I am secretary of the ironworks garden club, consisting of about 250 employees who are interested in bonsai, ornamental plants and landscape gardening. We have arranged many trips to bonsai nurseries, and also to potteries which manufacture bonsai containers. Our affection for bonsai creates a strong bond between the members, and we are peaceful among ourselves from living with nature as a friend. ✦

# COLLECTING A MOUNTAIN AZALEA

*Rhododendron kiusianum from Kyushu, southern Japan, must be potted in sand, protected from lace bug, trained by pinching rather than wiring*

**Shinichi Shibazaki**

ALTHOUGH several areas in Kyushu have wild plants suitable for bonsai culture, the two great mountain ranges on the island are especially well known for the many species they contain. At its high point the Mt. Yufu range is slightly more than 5,000 feet, while the Mt. Kuju range rises to almost 6,000. Beginning midway up these slopes grow such plants as Japanese white pine (*Pinus parviflora*), *Rhododendron metternichi, Enkianthus campanulatus longilobus* and, most famous of all, Kirishima mountain azalea (*Rhododendron kiusianum*).

Today most bonsai of *R. kiusianum* are started from cuttings, for the tree grows wild only in this vicinity, and Mt. Yufu and Mt. Kuju have been made national parks. But although plants can no longer be taken from their slopes, wild specimens of this mountain azalea can still be found in the hilly country near the big ranges. The plant is collected during its dormant period from November to March.

The most important step in adapting *R. kiusianum* to container cultivation is to remove all the mountain soil from the roots. If any is inadvertently included in the container, it seems to cause the roots to rot and the plant to die in two or three years. The only soil we use for these azaleas when they are grown as bonsai is a volcanic sand, which provides

Bonsai made from a collected specimen of Kirishima mountain azalea (*Rhododendron kiusianum*). This tree is 21 inches high.

On the mountainside, this 16-inch *R. kiusianum* was three-trunked, as well as "barefooted" (i.e., some of its roots were exposed). Two trunks were pruned away to induce branching toward the foot. Now the shoots at the top of the tree will be pinched back repeatedly to produce denser foliage, and the new branches at the foot will be trained into a complementary foliage mass.

perfect drainage. In transplanting a wild tree, a few strands of moistened sphagnum moss are placed around the roots to encourage growth of a dense root ball. Because of the shock to the roots as a result of removing all soil, a collected plant does better if its branches are cut back in order to reduce demands on the root system.

Kirishima mountain azalea flowers in the spring, different varieties producing crimson, pink, purplish pink and white blossoms. The white-blooming kind is rare and costly; the crimson comes next in value.

As soon as flowering is ended, the old flower parts should be cut off to prevent seeding, which weakens the plant. In the climate of Kyushu there is no need for winter protection, as these trees are high-mountain residents.

The lace bug is very fond of *R. kiusianum* and quickly gathers on the underside of its leaves, turning them yellow and killing the branches. It is easily controlled, however, by spraying the plant once a month with malathion.

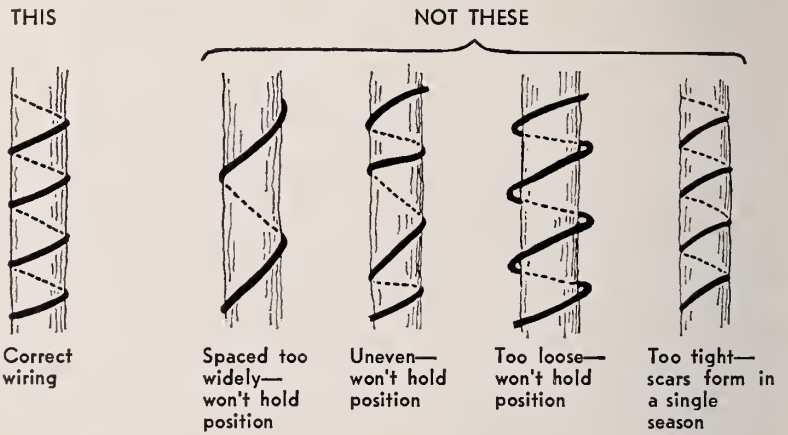
Unlike most other bonsai, this mountain azalea does not adapt well to wiring. Training is carried out by pinching or by tying branches with string, for any wire wrapped around them is likely to cause their death. *R. kiusianum* grows well on a stone, either by itself or as the secondary planting with a stone-clasping pine.

Three or four years are required to train a collected specimen, while it takes seven or eight years for *R. kiusianum* raised from a cutting to achieve a tasteful appearance. When the training period is over, however, this tiny-leaved and delicate-flowered azalea is a bonsai which its owner will be proud to display. ✦

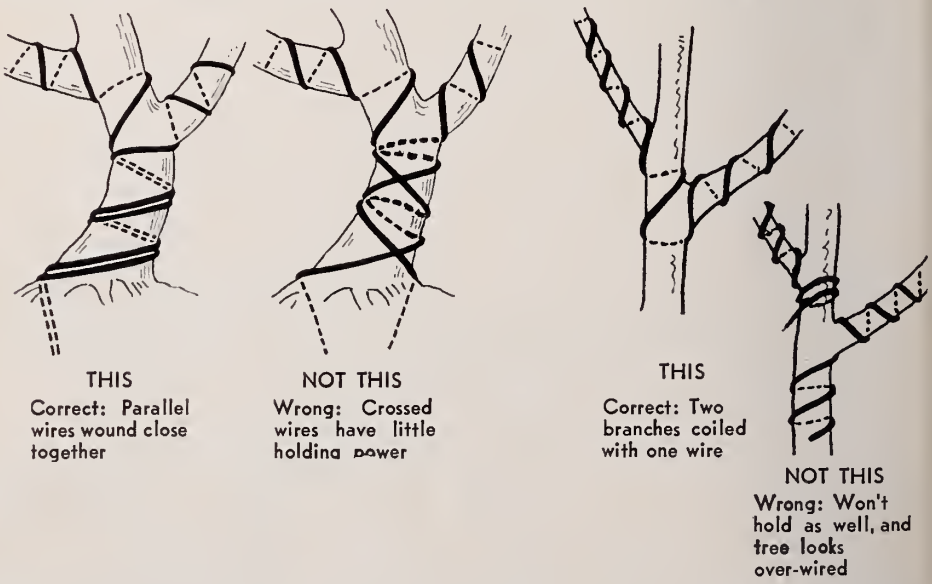
*R. kiusianum,* 18 inches high, which was uprooted from a mountain a year ago and cut back severely. Now it has leafed out enough for training to begin.

# WIRING TECHNIQUES

*"Never be in a hurry. . . . It is the hands which must do the learning, slowly and repeatedly until they can think for you."—Yashiroda*




Use no. 10 to no. 26 copper wire, depending on branch thickness and stiffness. Soften larger-size wires by bringing to a red heat in a flame and letting cool gradually. Once coiled around a branch, softened wire soon hardens.

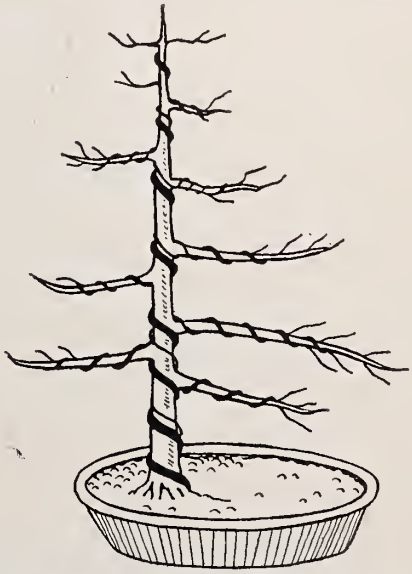



Begin wiring at bottom of tree and work upward. If trunk is to be wired, anchor wire ends by pushing down through root ball to a bottom corner of container. Avoid sheathing a tree in wire; good wiring practices give best results with least wiring.

# SHAPING A TREE WITH WIRE

*"Wiring has two purposes: to help the tree attain its ideal form, and to correct overlapping branches so that all can receive the sun and evening dew."—Saburo Kato*

Branches growing upward can be trained to slope downward or outward, suggesting the form of an aged tree.



Wind wire clockwise for training a branch to the right, counterclockwise for training it to the left. Wire should be of a size just stiff enough to hold newly bent branch in position.

*Drawings adapted from Toshio Kawamoto and Joseph Y. Kurihara, Bonsai-Saikei.*

# SPECIAL WIRING DEVICES

For training this young pine, wire was wrapped with cloth to protect the bark. Florist's tape can be used.

Guy wires are often a simple means of altering the form of an upright tree, as with this Japanese maple.

# TRAINING WITH PRESHAPED WIRE

*Buhle*

1. Five-year-old Atlas cedar *(Cedrus atlantica)*, pot-grown. 2. Pruning exposes main trunk; further pruning is carried out later as needed. Heavy iron wire the length of the tree is bent to desired shape. 3. Tree trunk is fitted to the wire (now painted white for visibility) and tied with stout cotton cord. Branches are wired to grow downward in small rippling curves. Note that tree has been turned around to show its best "viewing" side. (Tree was transplanted into bonsai container only for demonstration purposes; actually it should be left in the flowerpot for a year after it is wired. Then root pruning and transplanting can be carried out without endangering the plant's life.) If cord rots before tree has grown permanently into position, a matter of two to four years, it should be replaced.

# EZO SPRUCE*

## *"Leading a bonsai toward the shape one has in mind" by pruning, wiring and pinching*

Saburo Kato

If you travel in Japan someday, you will find that Ezo spruce *(Picea jezoensis)* is one of the most popular trees for training as bonsai. Public demand for spruce has increased many times over since new varieties with rare and delicate beauty were discovered on Kunashiri Island about forty years ago. Though Kunashiri is very close to Hokkaido (formerly called Ezo), its forest contained spruce of exquisite forms and characters that had never been seen in Hokkaido. Kunashiri Island was then a national park and its forest protected by law, but the governor of that territory, who was a bonsai fancier, allowed bonsaimen to collect specimens of naturally dwarfed Ezo spruce growing wild in the park. Soon these became a favorite throughout Japan. In 1945 Kunashiri, which is a part of the Kuril island chain, was occupied by the Russians and its forest closed to bonsai collectors. Some fine cultivated varieties have been developed from the original wild strains, however, and a tremendous number are propagated each year. This article on their training consists of excerpts from my book *Ezo Spruce, and Forest and Stone-Clasping Bonsai,* reproduced by the kind permission of the publisher Kashima Shoten.

### Pruning

EVERY tree has its own way of growing, and the basic pruning which gives it shape as a bonsai should reflect this as well as expressing an ideal form. While the grower plans the design he wants the tree to have, he should be carefully observing its individual character and habits of growth to see whether his ideas are truly suited to it.

For this reason I recommend that pruning be done not all at once, but over a few years as one watches the tree's reaction to his work. A plant pruned too quickly and forced into a preconceived pattern is likely to have its natural growth impaired. Some people, for example, are led by the plan they have formed beforehand into pruning back a weak branch, which then often dies and spoils the design. The grower who waits to develop a sense of the tree's own ways will learn to encourage the weak branches to produce denser foliage, while he cuts back the vigorous ones to keep them in scale. This slow and gentle approach to pruning is easier for the grower and kinder to the plant, and I find that it produces the best results. While gradually leading a bonsai toward the shape one has in mind and at the same time pleas-

*Although called **Yeddo spruce** in America, this name is erroneous. In Japan it is called **Ezo Matsu,** after its habitat Ezo—which is the island now called Hokkaido. Yeddo is the old name for Tokyo.

ing the tree, one can achieve the ideal pruning.

## Wiring

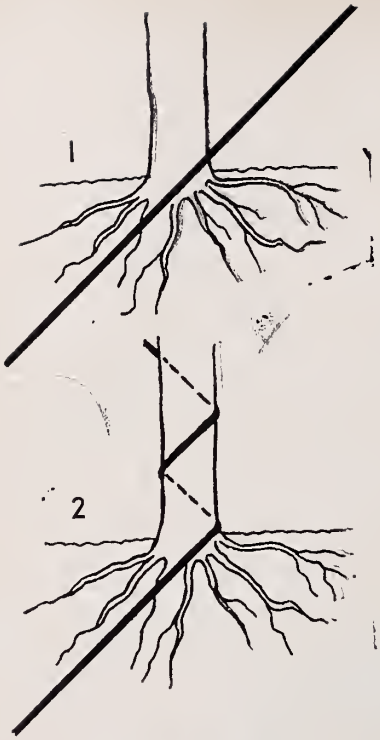
Wiring has two purposes: to help the plant attain its ideal form, and to correct overlapping branches so that all can receive the sun and evening dew. Thus I think it is a mistake to look at a wired tree as a persecuted plant; it is good for the tree to have a good result in the future.

Of course, one must be careful not to harm the tree in wiring it. Use copper wire in sizes ranging from no. 10 to no. 22, and soften the larger sizes by bringing them to a red heat (as explained on page 66). The two best times for wiring Ezo spruce are in the early spring and late autumn. However, a newly transplanted tree should not be wired for a year. If a cold spell comes in the autumn when a tree has just been wired, it should be kept under shelter.

As with pruning, one should study the tree thoroughly before wiring it. Plan the shape which is best for the design and best for the tree's growth; then decide the basic procedure of wiring. If the trunk is to be wired, wiring should start at the bottom as shown in drawings **1** and **2**, with a long piece of the wire-end anchored in the soil as closely as possible to the trunk. In wiring a branch, it is more effective to use a wire which connects two branches, as in **3** and **4**. But if this is impractical, a single branch can be wired by anchoring the wire-end under the heavier wire that has already been coiled up the trunk, as in sketch **5**, or

*Photographs countesy of Lynn Perry*

Ezo spruce *(Picea jezoensis)* growing on a rock. Travelers in Japan find this one of the most popular bonsai trees.



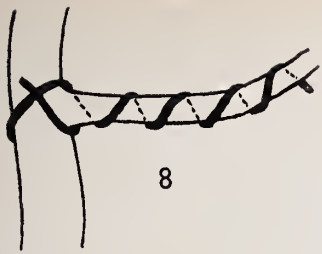

1 & 2: In wiring the trunk, it is important to anchor the wire properly in the soil.

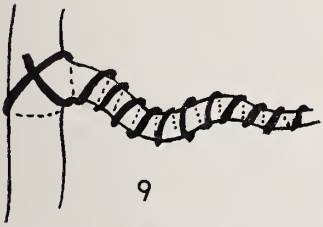
by fixing the end under its own loop, as in **6** and **7**.

Wire is coiled with the loops spaced according to the purpose of the wiring. The spacing shown in drawing **8** is suitable for lowering a branch somewhat or curving it slightly. But to put undulating curves into a straight branch, or to straighten a naturally crooked one, the loops must be closer together, as in **9**.

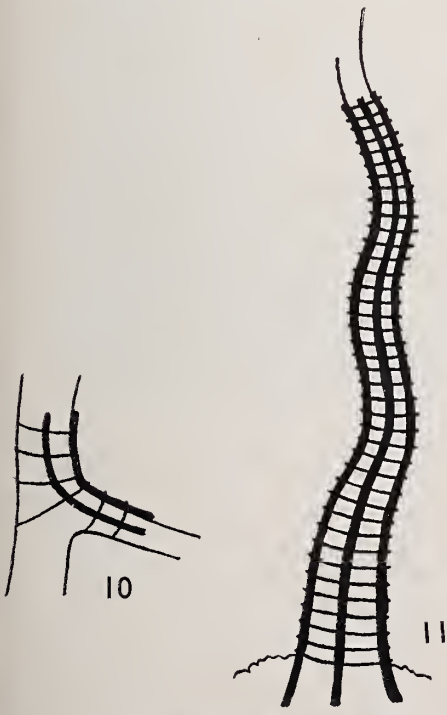
A most effective device is to combine coiled wire with wires running parallel to the branch. For example, this device may be useful with a limb which seems in

3 & 4: Wiring two branches with one wire. 5: Anchoring a wire under the main wire which is coiled up the trunk. 6 & 7: Anchoring a wire under its own loop.




8: Wire coils spaced for slight changes in shape of branch. 9: Wire coils spaced for drastic changes in branch.




10 & 11: Coiled wire combined with parallel wire braces. See similar technique on page 69.

danger of breaking if it is curved to slant downward by means of ordinary wire coiling. As drawing **10** shows, two rather heavy wires are bent into the shape the branch is to take, and these are lashed to the trunk and to the top of the branch with coiled wire. Braced in this manner, the limb is far less likely to fracture. A much thinner wire can be used for this type of coiling than would be necessary without the parallel wires.

As drawing **11** shows, the same general technique can be applied to an entire tree trunk, except that the parallel wires are placed all around it instead of only at the area of strain. In this situation it is an advantage that thinner wire can be substituted for the large and unwieldy sizes usually necessary for shaping a trunk. Another advantage of this method is that wiring scars are slow to form. By keeping the coiled wire away from the trunk, the parallel braces prevent injury to the bark even when the wire is left on for two or three years. As shown in the photographs on page 69, some bonsai experts use only one or two heavy guiding wires, and bind the trunk to them with strong cord.

Except in special circumstances, wire coiling is begun on the lowest branch and proceeds upward to the highest. Some bonsaimen prefer to finish all the wiring on a branch before moving up to the next, while others do the main wiring on all branches before they go back and wire the smaller twigs at the tips.

## Pinching

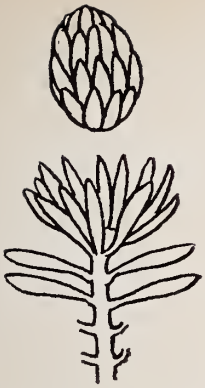
The new clear green needles of Ezo spruce which sprout and grow in the spring are so beautiful against the dark older foliage that they may almost be thought of as its flowers. The buds of Ezo spruce bonsai do not open simultaneously but in order of size, starting with the largest. It takes two weeks to a month for them all to burst, so pinching is begun with the earliest and is continued over a period of weeks. It seems a pity to pinch off such lovely buds; but if it is not done, the dormant buds will

"The new clear green needles of Ezo spruce which sprout and grow in the spring are so beautiful against the dark older foliage that they may almost be thought of as its flowers."

not sprout, growth will be untidy and the tree will become unkempt.

How is Ezo spruce pinched? The right time has passed when the new growth is fully developed; pinching should take place when the buds are only half sprouted. It is then quite easy to pinch them back by taking the end of a shoot between the tips of the forefinger and thumb and removing it as if pulling it off. If it is sliced off with a fingernail, some of the needles which remain on the tree are damaged and will turn an unsightly brown. After very little practice, anyone can become expert.

How far back should the shoots be pinched? This depends on many factors —the density of the old growth behind the shoot; the requirements of the design; the length of time the tree has been in



Pinch by taking the end of a new shoot between the tips of forefinger and thumb and pulling it off.

the container. Although the thickness and length of Ezo spruce needles vary from tree to tree, they can be controlled to some extent by several pinching methods. In general, one-third to one-half of a new sprout should be removed. The deeper the pinching, the thinner the new growth; the lighter the pinching, the denser the new growth. In a part of the tree where very thick foliage is desired, the new shoots can be left untouched.

When an Ezo spruce has been established in a container for years and is well shaped as a bonsai, it should be pinched back severely in order to preserve its form. Also, it will produce shorter needles if the new shoots are pinched earlier than the half-sprouted stage described above. Earlier the pinching, shorter the needles. In fact, if the needles are becoming too long and altogether untidy, the buds can be snipped off before they have begun to open. The growth from the next season's buds will be very much shorter and neater. Such drastic treatment should be limited to healthy and vigorous trees, however, and even then should not be done more often than every third year.

## Propagation

Ezo spruce is usually propagated by taking cuttings from the two- or three-year-old branches of a vigorous tree. The most favorable season is early spring before buds have sprouted. The customary way is to cut the twig on the slant with a sharp knife, remove the needles from the bottom of the cutting and push it at a slight angle into the rooting medium for one-third its length. If the cuttings are very small, they are inserted with tweezers.

The soil is then lightly pressed, and the cuttings are watered with a fine spray. The boxes of cuttings should be placed where they receive evening dew but are sheltered from sun and wind. For a month they are syringed three or four times a day, and the soil is prevented from becoming too dry or too wet. After this, the cuttings are syringed twice a day for two months; then they are gradually exposed to full sun, starting with an hour a day.

## Watering

Since bonsai are grown in a limited amount of soil, and since most are kept outside in the sun and wind, plentiful watering is very important. For bonsai which stay indoors away from direct sunlight, it is not easy to judge how much water they need. A general rule is to water them sparingly every day and copiously every third day. In winter, indoor bonsai are usually drier than one imagines and should be watered generously. I never saw any bonsai that died in the winter from root decay due to overwatering, but I know of many that died from drought.

## Fertilizing

Ezo spruces are fond of fertilizer, but they should not be given much at a time. Older trees are fertilized only once a month in their growing periods during the spring and fall; young trees can be given fertilizer twice a month in those seasons. Transplanted trees should not be fertilized for at least a month, however.

## Transplanting

Generally, spruce trees are transplanted every third or fourth year, although a tree in a large container can often be

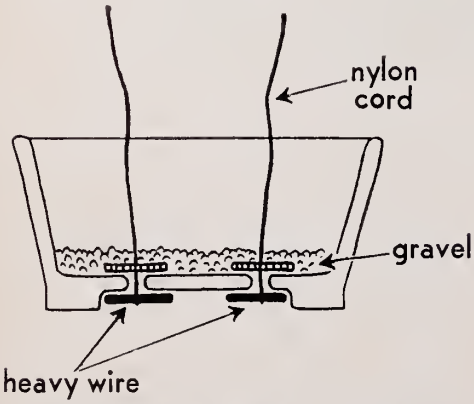
"I think it is a mistake to look at a wired tree as a persecuted plant; it is good for the tree to have a good result in the future."

left for six or seven years. The best season is in very early spring before the buds have expanded; other times are in the fall and in the winter after the weather has turned cold. It should never be done in late spring when the buds are opening.

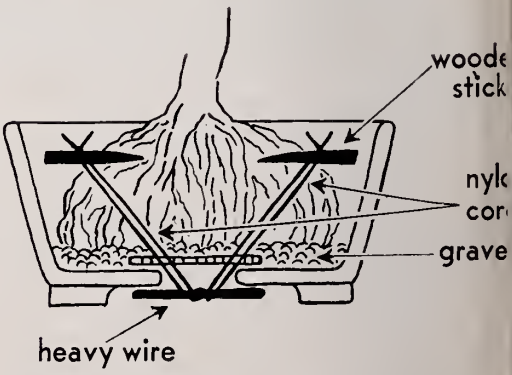
To transplant a spruce bonsai, tap the ball of earth out of the container and remove some soil with a chopstick. Starting with the bottom of the earth ball and then moving to the sides, take away half the soil for a young tree or one-third for an older tree. Examine the exposed roots carefully; use a sharp knife in cutting away decayed and damaged parts and pruning back some of the longer dominant roots.

Before repotting, prepare the container: Tie nylon cord to a short piece of heavy wire, cover the drainage hole with plastic screening and thread the cord through the screen. The drawings illustrate some ways to do this for a container with two holes and for a container with one hole. When there is one hole, the nylon cord can be tied to two short sticks which are thrust into the root ball as an anchor. There are many variations of these methods (for example, see page 25 in the Botanic Garden's Bonsai Handbook I); everyone will be able to develop his own.

As with all bonsai, a layer of gravel is put on the bottom of the container for drainage, and a layer of new soil is spread over it. After the tree is set in




Two-hole container: Tree can be tied in position with nylon cord.

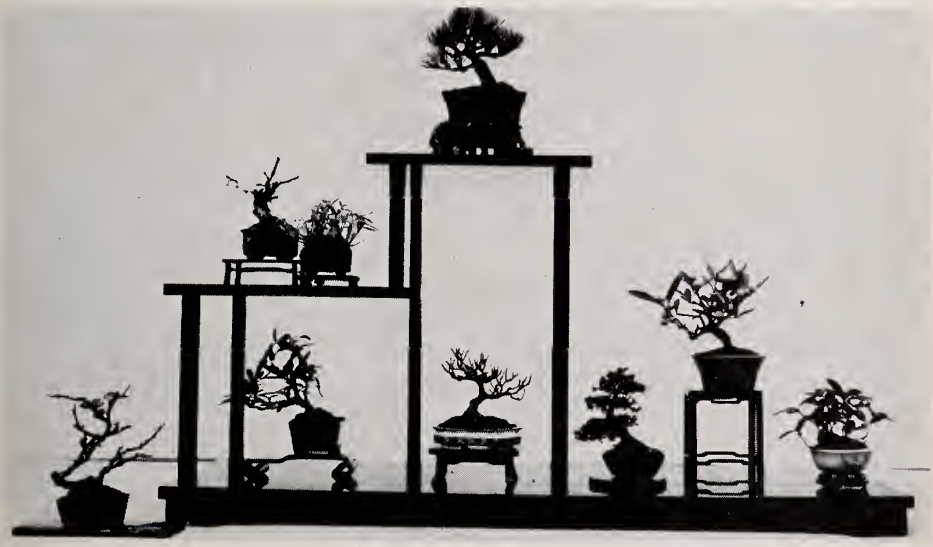



One-hole container: Tree can be anchored with sticks tied to nylon cord.

and anchored into position, new dry soil is added and worked around the roots with a chopstick. Finally, the surface is covered with either moss or ornamental sand [Americans may substitute parakeet gravel—Ed.]. The tree should be watered thoroughly so that water runs out through the drainage holes, and its foliage should be sprayed too.

Bonsai, which are created through our passion to express the varied beauty of nature artistically, require much technique to attain complete harmony between a container or stone and a plant. Besides, we must promote the strength of a plant to grow for itself, and must particularly respect its originality. If we always love and cultivate a bonsai, it will reveal its own nobility and personality as the years pass. The height of its beauty, shown according to the change of every season, gives us a deep impression and rest of mind. ✦

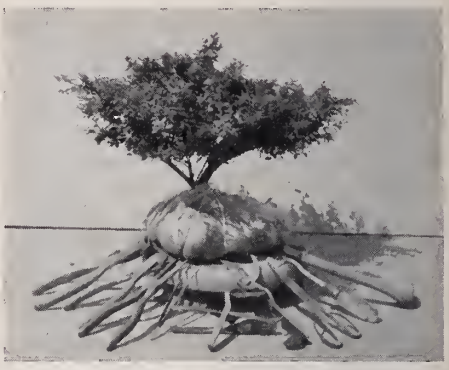
"While gradually leading a bonsai toward the shape one has in mind and at the same time pleasing the tree, one can achieve the ideal pruning."



*Miniature bonsai of many species on display at Sumiyoshi, Tokyo*

# TRAINING BONSAI: FIRST STEPS . . .

## Procedure by Frank Okamura



Start with this five-year-old Japanese holly (*Ilex crenata helleri*). Moisten, ball and wrap the root system of the freshly dug plant.

Study the branch structure, and prune away all but the key branches. Leave only those which are essential to the future character of the tree.

Dominant roots should be cut well back. Stiff, straight branches are given more graceful lines by wiring (see pages 66 to 69 for techniques).

# . USING A NURSERY-GROWN PLANT

Photographs by Robert S. Tomson

Root ball is much reduced in order to fit container. The two containers above illustrate steps in positioning pieces of screen over drain holes, inserting wire which will hold plant in container, and adding gravel for drainage. Foliage masses will develop in a single growing season from the basic "skeleton" shown here. (See page 4 for a picture of the same tree one season later.)

## BONSAI SHOULD BE WATCHED WITH CONSTANT AFFECTION

Bonsai is the art of planting a tree in a container, and growing it as a healthy plant by giving it enough care so as to be able to enjoy a miniature replica of graceful natural scenery. So it is important to watch over one's bonsai with unfailing affection. Any person who wishes to grow bonsai should spare at least ten to twenty minutes every day, either in the morning or the evening. Without such effort, successful bonsai growing can hardly be expected.

And if one has a true affection for his bonsai, he cannot fail to take notice of the drying of the soil in the container, the condition of the buds, color of the leaves and growth of the new shoots (which determines the amount of fertilizer to be given), the infestation by insects or disease, condition of the flowers and fruits, withering of the leaves, decay of the roots, etc. Upon finding defects, countermeasures must immediately be taken.

Adapted from Kyuzo Murata, *Bonsai: Miniature Potted Trees* (Shufunotomo Co., Ltd.)

# STORY OF A BONSAI PINE

## *Century-old collected pine responds to training within a few decades*

### 1925

JAPANESE red pine (*Pinus densiflora*) is shown at right as it appeared when presented to the Brooklyn Botanic Garden by Ernest F. Coe, then a nurseryman of New Haven, Connecticut. He had purchased it in Japan some years before. Originally a wild tree many decades old, it had been uprooted from a mountainside about 1910. Its potential for bonsai training lay chiefly in its picturesque exposed roots.

1925

### 1950

Although occasional pruning may have kept some order in the branches, no serious training was attempted, since no one on the Botanic Garden staff at that period was experienced in bonsai culture. Obviously the tree had not been root-pruned for many years. Besides the development of more branches and a larger root system, the only other change in twenty-five years was a thickening of the exposed roots.

### 1960

In process of training, by Frank Okamura. Pinching of the new shoots during each growing season resulted in denser foliage, while the branch structure was changed by pinching and wiring to form two levels of foliage. The tree had also been root-pruned and replanted with fresh soil.

### Now

The bonsai has settled into its new character and has been transplanted to a container more suited to its form. (See also the color photograph on page 45.) Although its appearance is very different today, its strongly curved main trunk was already well established in 1950. ✦

1950

1960 *Gottscho-Schleisner*

NOW *Pulitzer*

# ABOUT TRUNKS

## *And how to thicken them*

THE cotoneaster at right, a bonsai newly created from nursery-grown stock, is a charming example of the results that can be achieved with a young plant by skillful pruning and wiring. At the same time, this plant also illustrates two common defects found in young trees used as bonsai material, defects which no art of the bonsaiman can truly overcome. First, the thin, mostly straight stretches of the trunk lack the character which the passage of many years often brings to older trees. And second, as a result of the fact that the tree's main vertical growth occurred in one or two growing seasons, the trunk has almost no taper until it reaches the topmost branch. When the trunk of this bonsai is compared with the gnarled, undulating and gradually tapering trunk of the seventy-year-old pomegranate below, one can see that a major element in giving a bonsai character and an appearance of age is the trunk.

*Pulitzer*

Thick-trunked pomegranate trained by Kyuzo Murata.

*Roche*

Young cotoneaster trained by pruning and wiring.

How can a young tree be encouraged to enlarge its trunk while producing a gradual taper? There is no quick way to achieve such results; but techniques do exist for accelerating the natural process of trunk development.

### Pruning

The young Atlas cedar shown in three photographs at top of the next page was 18 inches high (*first photograph*), until its superstructure was cut away (*second photograph*), leaving only the two main lower branches and the spur at the right of the trunk. Next, most of the upper branch was removed from this abbreviated plant, so that the remainder of the branch became a short new leader (*third photograph*), which produces a tapered effect in its position at the end of the trunk. The new leader will become more vertical as it grows, or else it can be wired into a vertical position or into any other form. The taper from the tip of the leader to the base of the trunk will

Young Atlas cedar being pruned in a way to thicken the trunk and make it taper.

remain approximately in the proportion shown.

Why is the long horizontal branch left unpruned? Because the longer and stouter it grows, the thicker the portion of trunk below it will become. Both this branch and the spur will not be pinched or otherwise pruned for several years until the trunk diameter has reached the desired size; then they may be cut back as needed for the shape of the future bonsai. When one uses lateral branches in this way to "fatten" the main trunk, they should always be lower branches. Since each branch fattens the trunk immediately below it, the fattening produced by lower branches will accentuate the trunk's tapered effect.

## Fattening With Lower Branches

The small-leaved ash (*Fraxinus numidica*) in the photograph at right is a further example of fattening a trunk by allowing lower branches to grow without cutting them back or attempting to train them. The lowest branch fattens the foot of the trunk; the upper branches fatten the portion of trunk directly below them. Once the trunk of this tree has reached the desired diameter, there are several patterns into which it might be pruned to begin its training as a bonsai. For example, everything above the downward-curving lower limb at right could be re-

*Buhle*

Lateral branches left in place on a small-leaved ash in order to thicken the trunk in advance of bonsai training.

*Yashiroda*

Nursery bed of Japanese white pine at Kinashi. These trees will have thicker trunks than pot-grown specimens.

moved in order to train a cascade. This branch would then be cut back severely in order to initiate the same kind of taper training described for the Atlas cedar. A different possibility would be to cut away most of the downward-curving branch as well as most of the two long upper branches. Afterwards, shoots from these pruned limbs would be used to start a new trunk pattern for the upper part of the future bonsai.

## Planting in the Ground

In Japan a common technique for fattening the trunks of young bonsai is to grow them in the field for a few years. The picture above, for example, shows Japanese white pines in a nursery bed at Kinashi, a bonsai-raising center located on the Inland Sea. In the paragraphs below, Lynn Perry describes this trunk-fattening method:

"If you take two bonsai of like material and age (for example, two maples that are five years old which have been trained as bonsai from seedlings, cuttings, layerings, or nursery stock) and plant one in the container and one in the ground, the one in the ground will increase in trunk diameter over a period of two or three years much more rapidly than the one in the container, which may show little or no increase.

"Both trees are treated as bonsai, are root-pruned at the proper time, top-pruned throughout the growing season as required, watered, and fertilized on like schedules. The tree in the ground may need to be root-pruned again during the growing season. This is done by cutting around the root system with a spade and lifting it in order to halt the development of a tap root in species which have this type of root system. It is set back in the hole immediately. It may require less watering because its 'container' is much larger and does not dry out so rapidly. It may be wired in the nursery row if desired.

"The disadvantage of growing bonsai in the nursery row is that the trees are not in their containers and in their place in the grower's collection. However, the advantages to be gained by using this means of thickening the trunk of the bonsai are worthwhile. If the grower can wait as long as five years while the bonsai grows in the nursery row and is trained there—particularly root-pruned—fine specimens can be developed in a short period."* ✦

*Lynn R. Perry, *Bonsai: Trees and Shrubs—A Guide to the Methods of Kyuzo Murata.* Copyright © 1964, The Ronald Press Company, New York.

# BONSAI SOIL MIXTURES

## *A soil that holds both air and water is ideal*

George F. Hull

THE separate mineral elements that make up natural soils range from sand, the coarsest, to clay, the finest. Clay is so fine (particles below .002 millimeter) that water will penetrate it at a rate of only one foot a day, while sand (.05 to 1 millimeter) is so porous water will pass through 1500 feet of it in the same time. As might be expected, sand dries out quickly, while clay hangs onto moisture for a long time. Roots grow well in sand, if frequently supplied with the right amount of moisture, which accounts for the generous use of sand in mixtures for seedlings and cuttings. Roots find compact clay inhospitable, so grow slowly in it or perish, if it is poorly drained.

It is unusual to find either clay or sand in pure deposits. Natural soils are mixtures of materials of many sizes, created by such actions as the settlings of moving water as silt, deposits by the winds as loess, the accumulations of organic matter and minerals on forest floors, or the result of many other forces. These mixtures, which range somewhere between pure sand and pure clay, we call loam.

Loam is a combination of many-size particles. If most of these are very fine, it is called a clay loam. If of a medium-fine size, a silt loam. If coarse, a sandy loam.

The granular texture of a soil is not dependent entirely on the size of the mineral particles. Even clay soils, if properly treated—in "good tilth," as the farmer would say—have a granular structure, due to the fact that fine particles of clay form small clumps, with spaces between for the movement of air and water. The roots of plants require both air and water, and a good soil has a high percentage of air-water space in relation to its solid elements.

We usually think of loam as containing humus, a product of decaying vegetation and other organic matter. This organic substance adds to the fertility of the soil, soaks up large quantities of water, thereby making a sandy soil more moisture retentive; it increases porosity, thereby making a clay loam more open to the penetration of air, water, and roots. Humus sounds like the panacea for all soil ills, but used in high concentrations or alone, it is not. Gardeners have found that, under certain climate conditions, organic materials like peat moss or peat humus alternately can stay too wet too long, and then when dry, become actually water repellent.

The ideal soil would have the good qualities of the extremes—the structural porosity of sand, the water-retaining ability of clay—without the undesirable fast-drying characteristic of the former, or the inhospitable density of the latter. If we could create such a soil, and add the right amount of humus, then presto, we would have the perfect potting soil. It sounds magical and unattainable, but the Japanese have gone a long way toward attaining this ideal. How? By following two practices that are not generally known in this country.

First, they sieve their potting soils, retaining several granular sizes and—especially in the case of clay soils—they throw away the finest part. Second, they pot with dry soil. The theory is that the inclusion of the dusty part of fine soil

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From *Bonsai for Americans*, by George F. Hull. Copyright © 1964 by George F. Hull. Reprinted by permission of Doubleday & Company, Inc.

will fill up pore space, and that damp potting soil containing clay will lose much of its porosity if firmly packed into the pot. Dry soil can be tamped around the roots without destroying its granular structure. The tiny granules of clay act as reservoirs of moisture, and between them are the air-water spaces and the other materials of the potting mixture, the sand and humus.

All successful bonsai growers in this country do not follow these practices, but if clay soils are used, it is indicated. In cool, humid areas, where droughts are infrequent, moisture-retentive soil is not so important. And, of course, if watering is attended to frequently enough, a fairly light soil will serve almost anywhere. ✦

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# PREPARATION OF SOIL FOR BONSAI

*Screening Procedures at Brooklyn Botanic Garden*

| A | B | C | D | E |
|---|---|---|---|---|
| Soil which remains on top of 1/4″ screen | Soil which remains on top of 1/8″ screen | Soil which remains on top of 1/16″ screen | Soil which remains on top of 1/32″ screen | Soil which passes through 1/32″ screen DISCARD |
| **A** & **B** mixed for DRAINAGE at bottom of pot | | **C** & **D** mixed in equal parts LOAM MIXTURE* | | |

*The clay content of the loam determines its water-holding capacity.

## DIRECTIONS FOR MAKING AVERAGE POTTING MIXTURE

| LOAM MIXTURE | + | SAND or PERLITE | + | LEAFMOLD or PEAT MOSS | + | MANURE (Bovung) | + | BONE-MEAL | = | FINAL POTTING MIXTURE |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 parts | | 1 or 2 parts | | 1 part | | 1/2 part | | 1/2 part | | |

---

# ACIDITY OR ALKALINITY OF BONSAI SOIL

DETERMINATIONS of the pH (degree of acidity or alkalinity) of soils in which many kinds of bonsai grow successfully have shown a range of 4.5 to 6.5. Since pH 7.0 is the neutral point, a slightly acid condition is obviously best.

In general, acid-loving plants such as rhododendrons and azaleas do well within a pH range of 4.5 to 5.5. Pines and other needle-bearing trees normally grow in soils with pH 5 to 6. Indeed, most deciduous species that are used for bonsai (maple, hawthorn, flowering quince, pomegranate, cotoneaster, etc.) do well in the same 5 to 6 pH range.

If potting soil for a bonsai is taken from a place where similar plants are growing, there should never be a pH problem.

If necessary to make soil of a particular bonsai specimen more alkaline, add a light sprinkling of lime to the surface of the soil. To make it more acid, add a light sprinkling of sulfur. ✦

# SOIL CONDITIONERS

*Aids for soil drainage and aeration*

**Lynn R. Perry**

BONSAI GROWERS are generally aware of the importance of air as well as water in the soil of bonsai containers. The health of a bonsai depends on the presence of both, and both should move rapidly through the soil. If water lies on the surface and seeps but slowly into the soil mixture, it is a good indication that the mixture is too tight, i.e., soil aeration is poor. In some areas where soil tends to be "face-powder-fine," the problem of soil aeration and drainage in a bonsai container calls for special attention.

In Japan, bonsai soil mixtures usually include volcanic soil or sand, since it holds several times its own weight in water and generally promotes the growth of roots. Soils of volcanic origin are difficult to find in the United States except on the West Coast or Hawaii.

I have recently become acquainted with a soil conditioner called "Terra-Green," and another with the name "Turface" (available in regular and coarse grades; the regular is also available with nutrients added, and is sold under the trade name "Support"). These are clay, which is screened and baked. Because the clay has been baked, the particles are very hard and their shape cannot be changed. I find that when one of these soil conditioners is used as a sand substitute together with local soils, it is possible to go back to the recommended Japanese mixtures and have much the same results as if I were using soil of volcanic origin. For conifers I use 6 parts Terra-Green or coarse Turface and 4 parts soil. I use 6 parts soil and 4 parts of a conditioner for all other bonsai except when potting ericaceous plants. Then it is necessary to add 3 or 4 parts screened peat moss to the 6 parts soil and 4 parts conditioner. This reduces the number of potting mixtures in my nursery to three.

The results are almost immediately apparent. Excess moisture cannot remain in the soil; therefore bonsai plants cannot "drown." A smaller, finer system of roots forms rapidly. I also note that moss grows more rapidly on surfaces of soil mixtures which include the conditioners described. Turface is manufactured by Wyandotte Chemicals Corporation, Wyandotte, Michigan, and Terra-Green by the Oil-Dri Corporation of America, Chicago. Both are available in many garden and department stores. ✦

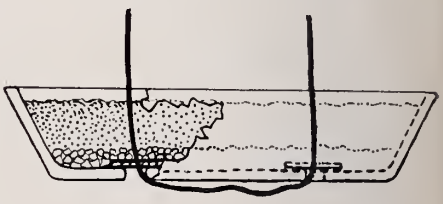
*From the collection of Heizaemon Ishihara, Nagoya, Japan*

# BONSAI ON A ROCK

*The goal of planting* a bonsai on a rock is to reproduce, in miniature, the natural appearance of a tree growing on a boulder or on a small rocky island in the sea. Plant in early spring just before the buds burst forth with new growth. Small-leaved maples and low-growing junipers are well suited for this type of bonsai.

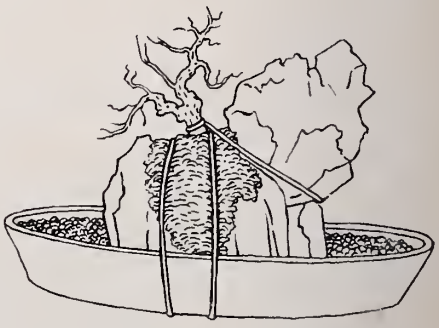
***Select a suitable rock,*** attractive in shape, age-weathered in appearance, and stable (that is, flat or essentially so) on the bottom. A saddle-like depression with miniature valleys descending from it is ideal.

***Planting tree on rock.*** Take a picturesque tree with well-developed roots and wash them free of soil. A thick coating of a mixture of clay and peat moss should be smeared on the rock where the roots are to grow. Divide the roots into three or four bunches, and position the tree on the rock so that it appears as natural and graceful as possible. String, raffia or stout rubber bands may be used to hold the base of the trunk firmly in place.



***Distributing the roots.*** Train the roots down the cracks or grooves in the rock, making them cling by applying more of the mixture of peat moss and clay. Add a few strands of sphagnum moss, placing them in contact with the roots, and fasten everything to the rock firmly with rubber bands, raffia or string.

***Preparing the container.*** Place screens over drain holes, and add gravel and soil as for growing any bonsai. Wires run through drain holes will fasten rock and tree as a unit firmly in the container. Or after planting, string or raffia may be tied around rock and the outside of the container to hold them securely.



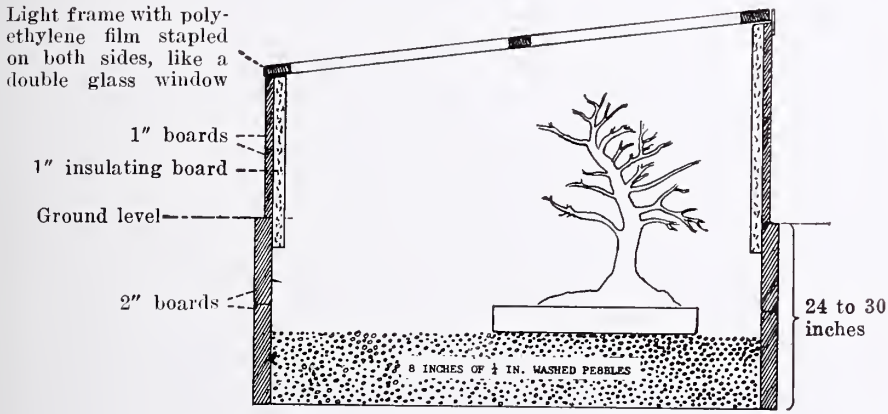
***Watering.*** Spray frequently with enough water to keep roots continually moist until they have grown down to the soil of the container. After this, treat the plant as you would any bonsai. For repotting instructions, see Seizan Ito's article on Stone-Clasping Bonsai. ✦

—Adapted with modifications from Kyuzo Murata's *Bonsai: Miniature Potted Trees* (Shufunotomo Co., Ltd., Tokyo).

# CARE OF BONSAI IN WINTER

*Cold-weather care—determined by climate*

**Kan Yashiroda**




Sectional view of deep coldframe suitable for the winter storage of bonsai in cold climates. The frame should be situated in shaded area completely free of winter sun (lath house shade is satisfactory). Plastic covered sash on top should fit tightly. As many as 30 plants can be stored in a 5- by 6-foot frame.

HARDY plants are those that can live outdoors in the coldest weather without danger of winter-killing. They are *not* house plants but are real outdoor plants. Typical examples are many kinds of pine, spruce, yew, retinospora (*Chamaecyparis* species), hemlock, cedar, larch, holly, maple, privet, flowering crabapple, hawthorn, rockspray, etc. These plants need cold to remain healthy and grow well. But be cautious!

Hardy species growing in bonsai containers present a special problem if left outdoors in below-freezing winter weather Soil in the containers will freeze, and the containers will often break. Moreover, it is impossible to properly water bonsai growing in firmly frozen soil.

If a sunporch or cold but light room is available where the night temperature never falls below about 36°F., this would provide a good place for overwintering hardy or semi-hardy bonsai.

Another suggestion is to keep the plants in a deep coldframe that is insulated. It should be shaded by a lath house. The soil in bonsai pots, with such protection, should never freeze if the night temperatures do not go much below 0°F. The bonsai should be watered as needed, and on warmer nonfreezing winter days, it is well to remove the protective covering and give the plants full air. Be sure to replace the covering sash before sunset.

If no garden space is available for such a coldframe, a large insulated wooden box might be constructed on a terrace. Its cover should be the same as for a coldframe. Soil in the box can be kept from freezing by the use of electric cable.

Many nonhardy or tender species trained as bonsai will grow satisfactorily if treated as house plants. Typical plants in this group are tender azalea, camellia, gardenia, box, dwarf pomegranate, firethorn and rosemary. ✦

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# PLANTS & GARDENS

## HANDBOOK ON WEED CONTROL

How to Control Weeds in Lawns, Ornamental Plantings, Vegetable Gardens, Woodlands, Aquatic Areas

Picture Dictionary of Common Weeds

Practical Help in Use of Herbicides

Weed Control Chart for Home Garden Use

AUTUMN
1966

NEW SERIES
*Vol. 22* *No. 3*

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# PLANTS & GARDENS

Published quarterly

Vol. 22 Autumn (November) 1966 No. 3

# HANDBOOK ON WEED CONTROL

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**Published quarterly at 3110 Elm Avenue, Baltimore, Md., by the Brooklyn Botanic Garden, Brooklyn, N. Y. 11225.** Second-class postage paid at Baltimore, Md., and at additional mailing offices. Subscription included in Botanic Garden membership dues. To others: $3.00 per year ($5.00 for two years). Copyright, 1967, by the Brooklyn Botanic Garden.
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# GLOSSARY OF TERMS USED IN WEED CONTROL WITH HERBICIDES

ACTIVE INGREDIENTS—the chemicals in a product that are responsible for the herbicidal effects.

AMINE SALT—a water-soluble form of an insoluble herbicide acid, usually an aqueous soluble concentrate.

ANNUAL—a plant that completes its life cycle from seed in one year; *see also* winter annual.

BASAL TREATMENT—herbicide treatment applied to the stems of woody plants at and just above the ground.

BROADCAST APPLICATION—an application over an entire area.

BRUSH CONTROL—control of woody plants.

CARRIER—the liquid or solid material added to a chemical compound to facilitate its application.

CONCENTRATION—the amount of active ingredient or acid equivalent in a given volume of liquid or in a given weight of dry material.

CONTACT HERBICIDE—a herbicide that kills primarily by contact with plant tissue rather than as a result of translocation.

DIRECTED APPLICATION—an application to a restricted area, such as a row, or at the base of plants.

DORMANCY—state of natural rest of seeds or other plant organs due to internal causes.

EMULSION—the suspension of one liquid as minute globules in another liquid; for example, oil dispersed in water, as with soap.

ESTER—an oil-soluble form of an insoluble herbicide acid, usually an emulsifiable concentrate.

HERBICIDE—a chemical used for killing or inhibiting the growth of plants.

HERBACEOUS PLANTS—plants that contain no woody tissue; annuals, biennials and nonwoody perennials.

PERENNIAL—a plant that lives for more than two years.

NON-SELECTIVE HERBICIDE—a herbicide that can be used to kill plants generally without regard to species.

PHYTOTOXIC—poisonous to plants.

POST-EMERGENCE—after the sprouting of a specified weed or crop.

PRE-EMERGENCE—before a specified weed or crop has sprouted from seed.

RATE—amount of active ingredient or acid equivalent of a herbicide applied to a unit area.

SELECTIVE HERBICIDE—a herbicide that will kill some plant species when applied to a mixed population without serious injury to other species.

SOIL APPLICATION—application of chemical made primarily to the soil surface rather than to vegetation.

SOIL STERILANT—a herbicide that prevents the growth of plants when present in the soil.

SOLUBLE POWDER—solid particles which can be dissolved in water, forming a physically homogeneous mixture, as with salt; *see also* wettable powder.

SPRAY DRIFT—the movement of airborne spray particles from the intended area of application.

TRANSLOCATED HERBICIDE—a herbicide which is moved within the plant from the point of entry.

VOLATILE—capable of evaporating, or vaporizing (changing from a liquid to a gas), at ordinary temperatures on exposure to the air.

WEED—a plant growing where it is not desired.

WETTABLE POWDER—finely divided solid particles which can be dispersed and suspended in a liquid, as with talc; *see also* soluble powder.

WINTER ANNUAL—a plant from autumn-germinated seed which blooms, fruits, and generally dies the following spring or early summer.

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WEEDERS ALL:

A bit of history: In the first issue of **PLANTS & GARDENS** (1945) there was a four page article on Weed-killing Chemicals. It began . . . "Getting rid of weeds is a perennially interesting topic to every gardener, amateur or professional. The dream is, of course, to kill the weeds and leave the crop." As the **CONTENTS** page and all that follows in this Handbook makes so clear, the "dream" of twenty years ago is on its way to universal practice.

Scientific research on herbicides has revealed that a particular chemical compound can mean death to one species, yet leave another unscathed. This is even more remarkable in the world of green plants than it is in modern medicine—wherein antibiotics can destroy disease organisms in a human host, yet leave the human little the worse for the experience. Humans and disease producing microorganisms are at opposite ends of the spectrum of life—a highly developed warm blooded mammal vs. species that consist only of a single parasitic cell—or not even that in the case of a virus. In contrast, "selective weed killing" with our newer chemical compounds means the destruction of certain species of flowering plants while others are left unharmed. Scientifically, this is but one of the early steps toward an understanding of the basic differences between species—another beginning, so to speak, in the further unraveling of the mystery of species.

Thus this handbook has unwritten philosophical meanings and implications in addition to offering guidance in the destruction of weeds—the unwanted. But enough of these stratospheric thoughts; it is time to turn to practical matters.

When we invited Mrs. Emerson to be Guest Editor of this publication, we knew that she in turn would invite top-flight collaborators to join her in the work. A glance at "Among the Contributors" makes it abundantly clear that the eighty information-packed pages that follow have been organized as selectively as the selective weed killers with which they deal.

It is a special pleasure to note that this Handbook follows—by exactly 20 years—the publication of **HORMONES** and **HORTICULTURE** (McGraw-Hill), in which my colleagues and I included, for the first time in book form, an account of the first known selective weed killers.

An index-summary of all the weed control recommendations given in the articles that follow. appears on pages 80-81. And additional weed control recommendations prepared by Guest Editor Emerson appear on pages 78 and 79.

Don't overlook "Creating new landscapes with herbicides" on pages 48-49!

George S. Avery

Director

MARCH 3 THROUGH MARCH 12

Special News Item for people in the Greater New York area and for New York visitors: In Philharmonic Hall, Lincoln Center, there will be an exhibition of the color photography of Mr. Leopold Pulitzer. All of his remarkably beautiful pictures were taken here in the Botanic Garden.

# THE SILENT TRAVELERS

## *Most eastern American weeds are invaders from abroad*

**John M. Fogg, Jr.**

WEEDS, no matter how they are defined, are so familiar even to non-gardeners that it is startling to realize that most of the plants considered as weeds in the eastern United States are not native there, but have come from other continents or from other sections of our own continent.

More than 12½%—1,051 species—of the flowering plants and ferns of the central and northeastern United States and adjacent Canada have been introduced from elsewhere. As covered in the comprehensive *Gray's Manual of Botany*, these are their places of origin:

| | | |
|---|---|---|
| Europe | 692 | species |
| Eastern Asia | 121 | " |
| Eurasia | 111 | " |
| Tropical America | 66 | " |
| Central and western North America | 44 | " |
| Others (Africa, South America, etc.) | 7 | " |
| Total | 1,051 | " |

While not all of these may qualify as weeds, a goodly number are, and some (to be considered later) have become aggressive pioneers. If weeds among strictly native plants are also counted, a rough estimate gives 1,200 species of weeds in the area considered. This is about 14% of the total number of species in Gray's Manual.

### The European Element

The overwhelming predominance of European species in our weedy flora has long been recognized and is easily understood. Among these nearly 700 kinds, it is highly instructive to note that 420 (or approximately 60%) belong to the following seven plant families:

| | | |
|---|---|---|
| Composite family (*Compositae*) (dandelion, hawkweed, bull thistle, Canada thistle) | 112 | species |
| Grass family (*Gramineae*) (Bermuda grass, timothy, crabgrass, annual bluegrass) | 65 | " |
| Mustard family (*Cruciferae*) (penny-cress, pepperwort, shepherd's purse, mustard) | 62 | " |
| Mint family (*Labiatae*) (ground-ivy, horse-mint and most other mints) | 60 | " |
| Pea family (*Leguminosae*) (clover, sweet clover, vetch) | 54 | " |
| Pink family (*Caryophyllaceae*) (chickweed, mouse-ear chickweed, bouncing-Bet) | 37 | " |
| Figwort family (*Scrophulariaceae*) (mullein, butter-and-eggs, speedwell) | 30 | " |

*Roche*

The sky-blue flowers of chicory (*Cichorium intybus*) decorate many American roadsides, yet this attractive European immigrant becomes a pest as soon as it reaches crop lands.

A significant feature of this list is that practically all of the genera in these families (at least in temperate regions) are herbaceous; that is, they are perennials, biennials or quick-growing annuals, rather than woody plants.

A second feature (not unrelated to the first) is that these families, in general, are regarded by the botanist as of recent evolutionary origin, in contrast to such ancient families as the magnolia (*Magnoliaceae*), barberry (*Berberidaceae*), laurel (*Lauraceae*), moonseed (*Menispermaceae*), custard-apple (*Annonaceae*) and others, which are primarily woody and which have made almost no contribution to the influx of weeds. If, as some botanists believe, modernity implies aggressiveness of pioneering vigor, then it is not surprising that the seven herbaceous families listed above should constitute such an impressive bloc of European immigrants.

Still another feature is their ability to produce enormous quantities of small seeds or, in the case of the Composites (hawk-weeds, dandelions, thistles, etc.), achenes which are equipped with tufts of hairs or bristles which greatly facilitate dissemination by wind.

The various means whereby European plants have contrived their passage to the New World have been so often described that only the briefest summary will be offered here; obviously, some were aided by human agency (intentional), while others got here on their own (inadvertent).

*Intentional Introductions.* To this category belong plants which were transported across the Atlantic Ocean by early colonists for one or more of the following reasons:

**(a) Ornamentals:** Plants such as cypress spurge (*Euphorbia cyparissias*), mullein-pink (*Lychnis coronaria*), bouncing-Bet (*Saponaria officinalis*), yellow toadflax or butter-and-eggs (*Linaria vulgaris*), and many others were introduced into the New World as attractive and familiar garden plants. All have escaped from cultivation and have become widely naturalized in our eastern flora. Today, they are generally looked upon as weeds.

**(b) Forage and Grazing Plants:** Numerous species of grasses important to livestock and such plants as alfalfa, clovers and vetch were brought to this country by early settlers and are now universally distributed.

**(c) Vegetables:** Many European culinary species, especially those from the Mediterranean area, were early transported to the New World. The list is long but includes, among others, radish, turnip, carrot and parsnip. All of these have escaped to become dominant weeds along roadsides and in open fields, vacant lots and farmlands.

**(d) Condiments or Kitchen Herbs:** This group includes such favorite and important seasoning plants as marjoram, basil, hyssop, thyme, caraway, dill, fennel, tarragon, mustard and countless others, not to mention such an indispensable pot-herb as purslane (*Portulaca oleracea*), which has become one of our most pernicious weeds.

**(e) Medicinal Plants:** Early immigrants brought with them many familiar

*Roche*

Butter-and-eggs, also called toadflax (*Linaria vulgaris*), is another imported weed with eye appeal. It was originally brought from Europe as a garden flower resembling snapdragon.

home remedies. Many of these, such as henbane (*Hyoscyamus niger*) have all but disappeared from our flora but others, like elecampane *(Inula helenium)*, have invaded widespread fields and pastures.

*Inadvertent Introductions.* To this group belongs the great majority of European adventives, or plants that have become naturalized. They arrived as stowaways in the rigging of ships, as impurities in shipments of grain and other seeds, in packing materials, on agricultural implements, but perhaps most prolifically in ship's ballast. In the early days a sailing vessel with a light cargo filled its hold with soil which was shoveled overboard at the first port-of-call, such as Boston, New York, Philadelphia, Baltimore, Charleston or one of the other eastern harbors. In this manner the seeds of hundreds of European species were introduced into Atlantic North America. The list of such adventives is prodigiously long and includes, to mention only a token few, many weedy grasses (such as crabgrass and goosegrass) wild garlic, the docks, many of the chickweeds and knotweeds, a host of mustards (including winter cress, pepper-grass and shepherd's-purse), bindweed, blueweed, hemp-nettles, several mulleins, common plantain, ribgrass, bedstraws and such ubiquitous Composites as whiteweed, burdock, thistles, chicory, dandelion, sow-thistle, hawkweeds, and the despised devil's-paintbrush.

In passing it must be emphasized that these modern, aggressive species from the open, sunny habitats of south-central Europe might never have gained a foothold in the New World had man left the country in the condition in which he found it, namely, that of deep, almost impenetrable forest. Instead he cut down the trees, ploughed the soil (thus upsetting century-old horizons), built villages, planted farms, laid out roads and railways and installed harbors. In short, he created exactly the kinds of habitats in which these visitors from abroad could readily establish themselves and from which they could rapidly spread throughout practically all of eastern North America.

*Gottscho-Schleisner*

The empress-tree *(Paulownia tomentosa)*, with large handsome clusters of lavender flowers rising from bare branches in the spring, is one of several Asiatic trees that have succeeded so well, especially in the eastern United States, that it has spread from private lands into adjacent forests. In short, it can become a weed.

## Eastern Asia's Contribution

In marked contrast to those plants which have come from Europe, the species which have been naturalized from eastern Asia are mostly denizens of woodlands, rather than of open sunny situations. For this reason they tend to be restricted in this country to shaded habitats, instead of fields, roadside banks, fallow farms and vacant lots. One of the most conspicuous and at the same time most pernicious of these species is the Japanese honeysuckle *(Lonicera japonica)*, which has taken over thousands of square miles of our eastern woodland, in many cases almost completely exterminating our original herbaceous vegetation. Another, though less obnoxious, example is the wineberry *(Rubus phoenicolasius)*, a raspberry relative which may be found in almost any piece of native woodland throughout the Middle Atlantic States. The Japanese hop *(Humulus japonicus)*,

unlike its European cousin, has made itself abundantly at home in the eastern United States, mostly in shaded situations, during the last two or three decades. Within a similar period a small annual knotweed from southeastern Asia (called *Polygonum caespitosum longisetum)* has undergone a phenomenal spread and is now found along woodland trails and in damp shaded spots from Massachusetts to Delaware and west to Kentucky and Illinois. The oriental bittersweet *(Celastrus orbiculata)* has become almost as abundant as its American cousin in many thickets and bottomlands. Several Asiatic trees have invaded our eastern forests and mingled with our native species; chief among them are the tree-of-heaven *(Ailanthus altissima)* and the princess- or empress-tree (*Paulownia tomentosa);* and south of Washington the silk-tree *(Albizzia julibrissin)* and the chinaberry (*Melia azedarach*) may truly be considered weed trees.

## Return from the Tropics

A million or so years ago, most of eastern North America enjoyed a climate far milder than that of the present—a climate which supported a warm temperate or sub-tropical vegetation. Then came the continental ice sheets and all that was changed. Since the retreat of the Wisconsin Ice, about 11,000 years ago, our climate has undergone progressive, though intermittent, amelioration and many groups of plants, such as the oaks, have been slowly migrating northward to reoccupy their former northern distributions. It is therefore perhaps not surprising that more than 60 species of plants from Tropical America should have insinuated themselves into our weedy community. Most of them are annuals, the seeds of which are capable of surviving our severe mid-northern winters.

Among them are Mexican-tea *(Chenopodium ambrosioides),* spider-flower *(Cleome spinosa)* and prickly-mallow *(Sida spinosa).* Several kinds of morning-glory *(Ipomoea)* abound and one of the most prevalent and persistent is the carpet-weed *(Mollugo verticillata).* The champion invader of them all, however, is a little annual which has not yet acquired a vernacular name but must still be called *Galinsoga ciliata.*

## Invasion from the West

The existence in the eastern United States of more than two score of plants from central and western North America is comparable to the presence here of so many species from the modern flora of southern Europe. In both instances the destruction of the original forests has facilitated the invasion of aggressive, sun-loving plants which are quick to take advantage of the artificial habitats which man has provided for them. The list includes several grasses from the plains and prairies, a scattering of pigweeds, mustards, legumes, evening-primroses, nightshades, the winged-pigweed (*Cycloloma atriplicifolia*), and, as one might expect, a fair representation of *Compositae* belonging to such genera as *Grindelia, Ambrosia* and *Rudbeckia.* It is difficult to imagine that such sun-lovers as evening-primroses *(Oenothera)* and black-eyed-Susan *(Rudbeckia hirta)* or even the common ragweeds (*Ambrosia*) were common in eastern North America, before the cutting of the forests created the open, sunny situations in which they have proliferated. The opening of highways and railroads has also greatly expedited the migration of prairie plants into our eastern states.

## Native Weeds

It must not be concluded from all that has been said above that eastern North America is totally lacking in its own weedy flora. By their very genetic constitution some species are more aggressive, faster-growing, more drought-resistant or better equipped for rapid propagation and dispersal than others. Thus it happens that such native eastern species as poison-ivy *(Rhus toxicodendron),* bindweed *(Convolvulus sepium),* honewort *(Cryptotaenia canadensis),* horse-nettle *(Solanum carolinense)* and horseweed *(Erigeron canadense)* must be considered as weeds along with plants introduced from other regions. ♦

# ELIMINATING WEEDS WITH HERBICIDES

## *Basic understanding needed of the ways and means of using special chemicals in weed control*

S. W. Bingham and C. L. Foy

ONE way of controlling weeds that invade our gardens, lawns and crops, even ponds, fields and woodlands, is with chemical weedkillers, or herbicides. Some of these are used as sprays or dusts on stems and foliage. Some are applied to the soil before weeds germinate. Trunks of trees and stems of rampant vines are painted, sprayed or rubbed with herbicides. Spot treatment of individual weeds is resorted to when a spray would damage nearby plants.

Some herbicides are said to be *selective,* which means that they will kill one kind of plant but not affect another. For example, the reason why 2,4-D (and its related compounds) may be used on lawns is that it readily destroys many kinds of lawn weeds — that is, the broadleaved kinds — but has little effect on grasses. For instance, atrazine, a frequently used herbicide, will not harm corn plants (corn is a cereal grass), but it will kill most weeds that infest the planting. On the other hand, there are herbicides that will eliminate grasses, but have little or no effect on broad-leaved plants.

Herbicidal selectivity, however, is relative, not absolute. A given compound may be toxic or nontoxic to a particular population of plants, a single plant, a plant part or individual cells, depending upon several conditions. While directions on containers are explicit, in order to know what kind of herbicide to use and how to apply it, one needs to understand something of the principles involved and the nature of the chemicals.

Unfortunately for gardeners, there is less distinction between the responses of desirable and undesirable plants than between the broad-leaved and grassy kinds. This is where the characteristic of selectivity is critical in determining the best material for the specified purpose. It also explains why there are relatively few compounds for killing broad-leaved pests like bindweed in a garden of roses, petunias or vegetables (all of which are also broad-leaved), or for killing weedy perennial grasses such as nimblewill in lawns.

Some selective herbicides work best through the soil, being absorbed by roots. Others are most effective when applied to the foliage. With still others both root and leaf uptake are apparently important. Some leaf treatment herbicides kill by contact while others move through the plant and induce a toxic response in some other part.

### How Plants are Classified for Weed Control

Regarding their response to herbicides, plants can be classified roughly as grasses and broad-leaved species. Most of the latter, but not many grasses, are sensitive to 2,4-D, and also to 2,4,5-T, silvex, dicamba and related compounds.

Grasses, on the other hand, are primarily destroyed by another group of chemicals, which are tolerated by many broad-leaved plants. These include dalapon, amitrole and atrazine.

## How Different Herbicides Behave

Herbicides that work best in soil, where they are absorbed by roots:
**dichlobenil, DCPA, bensulide**

Herbicides that are most effective when applied to foliage:
**2,4-D, dalapon, amitrole**

Herbicide with which both root and leaf uptake are apparently important:
**dicamba**

Herbicides that kill by contact with plant leaves:
**DSMA, dinitro**

Herbicides that move through the plant from the foliage or stems and induce a toxic response in some other part:
**dicamba, dalapon, 2,4-D, amitrole**

Herbicides that kill all plants on contact:
**common salt, sodium arsenite, diquat, borates, chlorates, fuel oils.**

Fluctuations in environmental factors such as temperature, relative humidity, light and nutritional status are known to influence the response of plants to herbicides. Conceivably, such changes could also induce differential responses among species.

The two peak periods of weed seed germination occur in early fall and spring. Herbicides are best applied then, either just before emergence or soon after seedlings begin to develop. Usually succulent young weeds respond more strongly to herbicides than do tougher, more mature plants. The germinating seed or very young seedling is the most sensitive. Prevention of weeds by early treatment is particularly important in the case of grassy kinds, even though destroyers in the form of post-emergence herbicides are available. In lawns, where previous crabgrass problems have existed, the pre-emergence herbicide approach gives control without the turf discoloration that is characteristic of post-emergence treatments. Garden plants may tolerate the low rates of pre-emergence herbicides that kill seedlings, but not the higher rates necessary to kill older weeds.

For post-emergence control, herbicide treatments are suggested during periods when the weeds are growing most vigorously. Control is usually more difficult when vegetative growth is slowing down, either as flowering starts or because of adverse environmental conditions such as dry weather. In short, many herbicides require an actively growing plant if they are to be absorbed and translocated to parts of the plant where the killing effect takes place. The underground stems or rhizomes of certain plants, for example, obviously cannot receive direct treatment. In hot dry summers and cold wet winters, vegetative growth may be slow, and conditions poor for treatment.

Broadleaf weeds that germinate from seed in the fall and establish rosettes before winter are best treated in late fall. When spring comes they reduce their vegetative growth and begin to flower. Control is more easily achieved at the earlier, rosette stage. Dandelions are a good example.

A few commercial herbicides are nonselective—that is, they kill every plant they touch. These are for use only where it is desired to remove all existing vegetation before starting a new planting. With them, special care is needed to avoid accidental contact with adjacent plants that are to be saved.

In identifying the weeds to be controlled, classification into grasses and broad-leaved species is helpful, but it is not enough to make a proper herbicide

## Pointers for Home Gardeners in the Use of Herbicides

Good management of planted areas is a fundamental aid in the fight against weeds. This includes the choice of plant varieties, their location as to sun or shade, the type of soil and its care through cultivation, watering and fertilization, and pest control for the plants. If a herbicide is required, there are more than 100 different chemicals and combinations of chemicals being used today in weed control. Choosing the right one for a specific job and using it correctly are imperative for control of weeds without damage to plants being cultivated. Here are some facts to keep in mind.

1. *Herbicides to be recommended* are kinds that are easy to apply, economical, safe for adjacent plants and safe for the operator. In selecting a herbicide for any food crop, be sure to choose a compound that has government approval for use on this crop. The label will tell.

2. *The primary safeguard* for any person using herbicides is to obey all instructions on the registered label required by law to be attached to the container. Follow directions *precisely* for each different situation, type of planting or crop. (Do not follow the old adage, "If a little bit will do a good job, a little more will do better." With herbicides, a little more can damage desirable plants. Conversely, a little less is likely to be ineffective on the weeds.)

3. *Preventing seed production in weeds* makes the job of control much easier. Allowing several flushes of weeds to germinate, then destroying them by thorough tillage, will help to reduce the weed problem.

4. *Stage of growth* is a significant factor in weed control. In general, pre-emergence herbicides applied to a clean-cultivated area as the weeds begin to sprout, prevent the appearance of weed seedlings. If weeds are already in evidence, spraying is most effective when they are growing actively.

5. *Soil moisture* affects herbicidal action, especially with pre-emergence treatments. If insufficient moisture is present in the soil, the herbicide will not work.

6. *Soil type* affects the behavior of the chemicals used. Heavy soils generally require higher rates than light, sandy soils. This is usually indicated on the label.

7. *To gauge the proper application* of a herbicide for a given area, equipment should be calibrated before commencing the job. *(See page 45).*

8. *Avoid using herbicides* near wells, streams, lakes or ponds in such a way that water is contaminated either by direct contact or by seepage of the chemical through the soil.

9. *Do not spray* on a windy day.

10. *Common reasons for failure* with herbicides are: (1) improper application or incorrect measurement (see note 7 on calibration); (2) lack of sufficient moisture in the soil; (3) applying the herbicide at the wrong time (season, stage or condition of plant growth); (4) unfavorable conditions of weather or soil; (5) using a herbicide that is unsuited to the specific situation or purpose.

selection. For example, among the grasses: Crabgrass is an annual plant that reproduces by seed and is readily controlled with an appropriate herbicide before it emerges from the soil. On the other hand, Bermuda grass is a perennial species that reproduces by vegetative means as well as seed, and requires a herbicide that will control an actively growing mature plant.

If in doubt about identifying the weed species that are your greatest problems, consult the Extension Service, your State Agricultural Experiment Station, your nearest botanic garden, a commercial company representative, or appropriate literature for positive weed identification before adopting a particular weed control practice. ♦

# HERBICIDE TOXICITY

## *Tests show that dangers of use are minimal*

**Donald J. Lisk**

IN the relatively few years since selective chemical weedkillers first became available to gardeners and farmers, they have become among the most important tools for controlling pests. Intensive research has greatly increased their number and variety. In 1955, farmers could choose from among 14 herbicides. Ten years later, in 1964, 125 basic chemicals were available in about 8,000 registered products.

Fortunately, feeding trials with laboratory and other animals have shown most herbicides to be among the agricultural chemicals least hazardous to man. Many researchers in universities and governmental agencies are investigating what becomes of herbicides in plants and animals, as well as in the soil. Thanks to the development of rapid isolation techniques and the revolution in modern electronics and instrumentation, metabolism studies have been greatly facilitated. The chemist's ability to rapidly and routinely detect a few parts per billion of many herbicides and their decomposition products in plant or animal tissue is comforting.

Federal control over the safety of herbicides is handled by the U.S. Department of Agriculture and the Food and Drug Administration of the U.S. Department of Health, Education and Welfare. Approval of both agencies must be obtained before a chemical weedkiller may be legally offered for sale.

The U.S.D.A. requires manufacturers to register their chemical labels and to provide detailed information on the chemical's effectiveness for the intended herbicide use, and its safety for the user, other people or animals in the area, and to other crops when used as directed. Data on the persistence of the herbicide in the soil with possible adverse effects to susceptible plants, animals or aquatic species in subsequent years is also sought.

The F.D.A. requires complete information on (1) the amount of the chemical and metabolites that may remain on harvested food crops, if any, (2) a practical and sensitive analytical method of detecting the substances, and (3) reported harmful effects of long-term high-level feeding experiments on test animals. Only then may tolerances be established for residues of the herbicide at harvest, each having a 100-fold safety factor, with an automatic zero tolerance for any chemical in milk and for highly toxic compounds or carcinogens. The cost to industry in securing this information has ranged up to several million dollars per compound.

F.D.A. and many state agencies have inspectors throughout the nation who constantly sample harvested food which is then chemically tested for possible excessive herbicide residues. If excesses are found, the commodity is then seized. Analysis for possible pesticides in purchased food comprising total human diet is now being conducted periodically by F.D.A. researchers to ascertain possible hazards. No significant residues of herbicides have been found.

Numerous generous grants from federal and state agencies and industry are now supporting much-needed additional research on possible herbicide hazards. Projects include studies of the effects of pesticides on wildlife, the analysis of potable water for residues, complete studies of the metabolism of pesticides in plants, animals, and soils, synthesis of new compounds which are more selective for control of the target pest and less toxic to desirable plant and animal species, studies involving methods of formulation and application of pesticides to reduce drift and minimize harvest residues, development of new sensitive analytical methods for detecting these compounds, and many others.

Government and industrial officials have also established highly organized

(*Concluded on page 75*)

# WEED CONTROL IN LAWNS

## *Good management practices should precede the use of chemical weedkillers*

C. R. Skogley

"THERE are many millions of dollars spent on education every year and yet there are still many who cannot understand that when weeds come up in a lawn it is a perfectly natural occurrence. In fact it would be unnatural if they did not. Every part of the earth's surface contains seeds or spores of some sort of weed or another. It is essential for the turf manager to fight weeds year after year if he desires the very best in turf." This sentiment was expressed by Mr. R. Beale in *The Book of the Lawn* published by Cassell in England in 1931.

Fortunately, progress in turf management has been made in these 35 years, so the fight against weeds no longer need be the chore it once was. The arsenal of knowledge, equipment and chemicals for easier and better lawn production has grown mightily in recent years.

The fight against weeds starts with good management. This includes the use of improved adapted varieties of grass, proper establishment procedures, proper cutting and watering, meeting the nutritional needs of the grass and controlling lawn insects. A few weeds may appear in the best of lawns but the problem becomes major only when the grass loses its vigor and density, thus can no longer compete.

In the northern United States Kentucky bluegrass and red fescue are the two most widely recommended lawn grasses. Improved varieties of both are available and worth the small price premium. The bluegrass performs best in good sunny locations, while red fescue will do well in either sun or shade. For quality lawns, seed mixtures containing coarse grasses such as tall fescue or those listing high percentages of annual bluegrass or other weeds should be avoided.

### Preliminary Procedures

Most lawns are best seeded in late August or September, otherwise in early spring, using 3 or 4 pounds of seed for each 1,000 square feet of lawn area. Attention to procedures at the time of establishment is worth the effort. For example, at the start:

> *Use plenty of limestone and fertilizer*, incorporating them well into the upper 3 to 6 inches of soil before seeding.

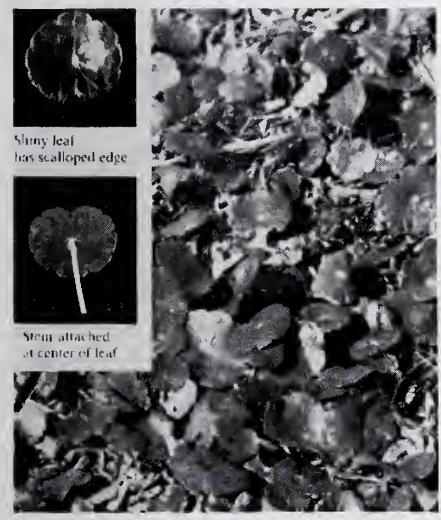
*Scott Seeds*

White clover *(Trifolium repens)* can be kept out of lawns with a number of herbicides, notably silvex, dicamba or mecoprop, but they should not be used in hot dry weather.

*Firm and level the seedbed well* to avoid areas that would be scalped by the mower or depressions in which water might stand. Both of these could be potential weed patches.

*Mow the grass when it is about 3 inches high.* The cutting height for bluegrass-fescue lawns should be 1½ inches or more. Mowing should not be on a set schedule but according to rate of growth. This may be every three to four days in spring or fall and once every week or two during the summer. Mowers should be sharpened and adjusted to maintain a precision cut. Dull mowers tear or shred leaf blades, thus weakening the grass and causing poor performance and appearance.

*Do not overwater lawn grasses.* They perform best on moderately moist soils—not wet soils. The results of light, frequent watering or of keeping the soil saturated are shallow-rooted grasses and promotion of annual bluegrass, crabgrass and other weeds. The best way to apply water is to soak the soil to a depth of 6 to 8 inches only as often as needed to maintain growth. This is seldom oftener than once every seven to ten days.




*Scott Seeds*

**The shiny, rounded leaves of lawnpennywort *(Hydrocotyle sibthorpioides)* are a common sight in shady areas. Herbicides designed for lawns, if repeated, will keep it under control.**

## Care of Established Lawns

Many soils of the Northeast are acid and infertile, so periodic applications of limestone and fertilizer are needed to maintain vigorous growth of lawn grasses. On established lawns 25 pounds of ground limestone per 1,000 square feet may advisedly be used each year, or 50 pounds every second year. While it may be applied at any time, it is put on most frequently in late fall.

Fertilizers for established northern lawns should be applied at least twice a year—in April and September. Additional applications may be desirable to maintain deep green color and good growth during the entire growing season. For thin, weedy lawns a high phosphorus fertilizer such as a 5-10-5 is suggested: 20 pounds per 1,000 square feet for each application. Where good stands of turf exist, a high nitrogen fertilizer is recommended. A 10-6-4 grade at 10 pounds per 1,000 square feet is commonly used. The lawn should be well watered after fertilization.

Lawn insects such as chinch bugs, sod webworms and soil grubs can ruin good lawns rapidly. An insecticide applied to the lawn once every three to five years will protect against damage. For other lawn insects a recommended insecticide should be used at the first sign of injury.

## Control of Lawn Weeds

With good management, weed encroachment will be minimized but not eliminated. Crabgrass, dandelion, plantain, chickweed, clover and a number of less common weeds may still make an appearance. When they do, they can be removed with chemical weedkillers. Many fine products are available for the job. Proper application and timing are essential for effective and safe use of the chemicals. Label information is usually complete and will give detailed instructions for proper use—so *read these instructions carefully.*

For applying granular herbicides, as well as fertilizer, to a lawn, this type of spreader is practical. It can be regulated so that a specified amount will be released evenly over a given area.

A compressed air sprayer, slung over the shoulder, enables an operator to deliver a steady supply of herbicide to a weedy area without the necessity for constant pumping.

### *Crabgrass*

Crabgrass is best controlled in very early spring, two to three weeks before its seeds are ready to germinate. The several crabgrass preventers available are most frequently used in the dry form—either alone or with fertilizer. The names of the common ones are Azak, Bandane, Betasan, Dacthal and Tupersan.

Once crabgrass has emerged, control is more difficult. Organic arsenicals, such as DSMA and AMA, are most useful for this purpose. Both liquid and dry forms are available; two or three applications at weekly intervals are required. (For more details on crabgrass, see page 19.—Ed.)

### *Broad-leaved Weeds*

Broad-leaved weeds can be controlled with various selective, hormone-type weed killers, such as 2,4-D. Control of most weeds is best accomplished in late spring or early fall when soil moisture is plentiful and both weeds and turf grasses are growing strongly. Treatment during hot or dry weather may result in failure or in lawn injury.

Dandelions and plantains are easily killed with 2,4-D, as are a number of less common lawn weeds. The chemical is available in both liquid and dry forms.

Chickweed and clover can be eliminated with silvex, dicamba, or mecoprop. During periods of high temperatures, silvex may cause some turf discoloration and must be used with extra care, especially on bentgrasses.

A few weeds formerly considered resistant to weedkillers can now be controlled with dicamba. These include knotweed (*Polygonum aviculare*), sheep sorrel (*Rumex acetosella*) and yarrow (*Achillea millefolium*). Response is sometimes slow, but eventually good. This chemical must be used at rates *exactly* as the manufacturer directs, because slight overdosage can be absorbed by tree or shrub roots in the treated area.

To kill as wide a range of weeds as

possible with a minimum of application effort, combinations of selective weedkillers are formulated and marketed as "broad-spectrum" herbicides. Combinations of 2,4-D with dicamba, silvex or mecoprop provide weed-killing compounds that can control most broadleaf weeds. A single application is usually adequate.

In general, liquid formulations are more efficient than dry ones, but the latter require no mixing and are easier to use. There are several methods of application, and the choice will be decided by the size of the lawn, type of herbicide formulations available and personal preference. One of the simplest methods is to apply granular forms with a mechanical spreader that is adjusted to the setting specified on the bag. A second method is to apply liquid forms with a knapsack or pump-type sprayer. The product is added to water in the sprayer, mixed well and sprayed onto a measured area.

A third method is with a hose proportioner. This is the bottle-type sprayer that fastens to the end of a garden hose. Although not as accurate as other applications, it is inexpensive and applies material rapidly.

A recent development for liquid application of weedkillers is the gravity flow "Meter-miser." The chemical is added to water in the tank and the "Meter-miser" is pushed over the lawn in the same manner as the dry spreader for dry formulations. As long as the proper amount of chemical is added to the water in the tank, it is not necessary to mark off the area to be treated.

Label directions are important. They give instructions as to rates, time of application, weeds controlled and cautions in handling and applying. *Read the label thoroughly before using these products.*

Chemical control of weeds can be very successful. It is only a temporary expediency, however, if not accompanied by a continuous program of good lawn management. ♦

A hose proportioner, properly adjusted, is one of the simplest ways for a home owner to spray his lawn weeds. Either a dry or liquid herbicide can be put in the container.

The "Meter-miser" is a gravity flow applicator, with which it is unnecessary to mark off the area to be treated, as long as the proper amount of herbicide is added to the water.

# WARM-CLIMATE LAWNS AND THEIR WEEDS

## *Herbicides can eradicate plants whose conspicuous foliage mars the beauty of a lawn*

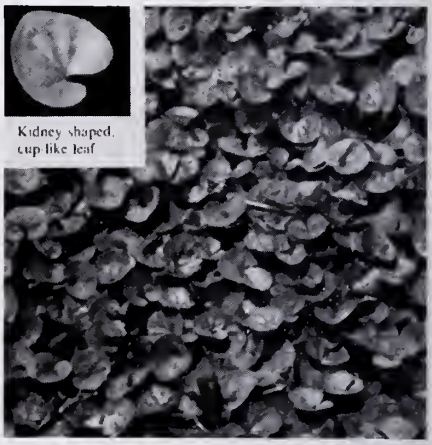
E. O. Burt

WEEDS rank as one of the most troublesome pests of southern turf, as well as lawns in other warm areas. Some are especially undesirable because they are so conspicuous in lawns. The shiny round leaves of dichondra (*Dichondra repens*) and of pennywort (*Hydrocotyle*) differ greatly from turfgrass leaves. Creeping weed grasses such as the exclusively southern crabgrass (*Digitaria serotina*) and the signalgrasses (*Brachiaria* species), are unsightly and smother turf. Bunch-type grasses like bullgrass and Dallis grass (*Paspalum* species) also detract from the beauty of a lawn.

Some southern weeds have a dual personality, fulfilling the definition of a weed as "a plant growing where it is not wanted" and also being cultivated. For example, selected strains of Bermuda grass are used extensively for lawns. On the other hand, patches of Bermuda grass volunteering in other types of turf place it among the most annoying of weeds. Likewise, dichondra is enthusiastically used as a grass substitute in California, but is more commonly considered a weed in Florida, where it invades turf.

Weeds are generally the *result*, rather than the *cause*, of poor turf. There is no substitute for proper fertilizing, watering and mowing.

The first step in developing a weed-free lawn anywhere is to select the grass most suitable for the particular situation. In the South, this may be zoysia, St. Augustine, Bermuda grass, or even centipede or Bahia grass, depending upon the soil, the local climate, and the expected use. The soundest basis for avoiding weedy turf is to use high quality, weed-free sod or to plant seed on soil that is not infested with perennial weeds, especially with weed




Dichondra (*D. repens*) is sometimes used in place of lawn grass in warm, dry climates, but when it becomes an invader of good grassy turf, lawn herbicides are needed to control it.

Yellow wood-sorrel (*Oxalis corniculata* or *O. repens*) is characteristic of acid situations. It can be treated with the herbicides that are used on clover (see page 12).

grasses or such sedges as nutsedge (*Cyperus rotundus*).

The second step is to treat the turfgrass according to its needs. Proper lawn management practices can produce a dense, vigorous turf which resists weed invasion. Lawns weakened by chinchbug or other insects, by nematodes or by disease become thin and invariably weedy, and control of these pests will help prevent weeds from gaining a foothold.

Each kind of grass should be mowed regularly within a specified range of heights. To cut higher or lower will weaken the grass and encourage weeds. Frequently St. Augustine lawns are mowed at less than the recommended height of 1½ to 2½ inches. Many Bermuda grass lawns are also mowed too close. Tearing grasses with a dull mower is a further invitation to weeds.

Too many lawns do not receive enough fertilizer to keep grass growing well. Furthermore, if damaged, starved grass cannot heal and fill in rapidly enough to keep weeds from becoming established. These troubles can be minimized by providing adequate fertilizer regularly.

One of the most common causes of weeds in lawns is improper watering, either too much or too little for the particular grass. Watering too frequently can also contribute to poor turf by encouraging germination of weed seeds.

When a weed does appear in a lawn, pull it out at once. Do not wait until the lawn is heavily infested to start the clean-up. Above all, do not introduce weeds into a lawn by using weed-infested topsoil or topdressing.

Despite all that homeowners can do in managing high-quality, well-adapted turf, certain aggressive weeds do invade and become established. There is an abundance of weed seeds in most soils. Any change that exposes these seeds to light and moisture—weakened turf or disturbed soil—gives weeds an opportunity to invade the lawn. Once established, they run rampant unless effective control measures are taken. If this happens, and weeds gain a foothold, chemical weedkillers can be useful in eliminating them.

## Methods of Applying Herbicides

### *Pre-emergence*

Pre-emergence herbicides are those applied just before weeds emerge. They kill seedlings that are trying to grow through treated soil, rather than killing dormant weed seeds. Adequate soil moisture during this period is therefore necessary for germination of the seeds and subsequent weed control. These herbicides remain active in the soil for a month or more.

Pre-emergence herbicides are useful on newly sprigged turf that has been verticut or sanded, unless sterilized soil was used, when they would scarcely be necessary. They are generally safe to use around ornamentals. Since most of them kill the germinating seeds, rather than established weeds, they should not be applied within 30 to 60 days of overseeding.

### *Post-emergence*

For treating weeds that have already emerged, it is important to select the right chemical to control the specific weeds present without injuring the turf. Some herbicides can be used with a degree of safety on certain turfgrasses but will kill others. When in doubt, it is better to repeat a light treatment than to regret a heavy one.

Adequate watering and fertilization several days before applying selective herbicides insure active growth of turfgrass and weeds alike, and may thus increase weed kill and reduce the chance of turf injury. Good management practices encourage grass to fill in where the weeds have been eliminated.

## Types of Herbicides

Successful use of herbicides depends on *the proper chemical* at the right time and in the correct manner. These materials fall into four general groups. The grasses on which they may be used are listed at the end.

1. *Prevention of seed germination of troublesome weeds.* Atrazine and simazine are closely related chemicals which can kill seeds as they try to germinate in the soil. They are also able to control many established weeds, creeping beggarweed

(*Desmodium canum*) being a notable exception.

2. *Killing of weedy grasses at start of seed germination.* Azak, Bandane, Betasan and Dacthal are all herbicides which prevent the emergence of weedy grasses such as crabgrass (*Digitaria*), goosegrass (*Eleusine indica*) and others. They must be applied pre-emergence, that is, before seeds of these pests begin to germinate, in order to affect the growing tip as it pushes through the seed-coat into the soil.

3. *Elimination of established weedy grasses.* If time has slipped by so fast that weedy grasses have germinated and grown, the arsenicals are useful. The group includes chemicals known as DSMA, CMA and AMA, all effective for killing established grassy weeds such as bullgrass, crabgrass and sandspur (*Cenchrus tribuloides*). Repeated applications will even reduce stands of nutsedge.

4. *Killing of broadleaf weeds without injuring turfgrasses.* The familiar 2,4-D, also 2,4,5-T and silvex, comprise perhaps the most useful group of weedkillers, the selective substituted phenoxy compounds. These are highly important because they can kill most broadleaf weeds without injuring most grasses, thus ending the necessity of pulling or cutting weeds out of lawns. Silvex controls creeping beggarweed, black medic (*Medicago lupulina*) and clovers better than 2,4-D does. On the other hand, 2,4-D kills a wider range of broadleaf weeds. For these reasons, the materials are often combined into a single product.

## Chemicals for Weeds in Southern Grasses

***St. Augustine grass***

*Atrazine or simazine*
Use on:
germinating weed seeds
established weeds, except creeping beggarweed
*Azak, Balan, Bandane, Betasan* or *Presan, Dacthal* and *Treflan*
Use to:
prevent germination of crab-, goose-, and other grasses

***Zoysia grass***

*Simazine or atrazine*
Use on:
germinating weed seeds
most established broadleaf weeds except creeping beggarweed
*2,4-D, 2,4,5-T, silvex*
Use on:
established broadleaf weeds
*2,4,5-T or silvex*
Use on:
creeping beggarweed, wood sorrel, black medic, clovers
*DSMA, CMA, AMA*
Use on:
established annual grass weeds—bluegrass, crabgrass, sandspur

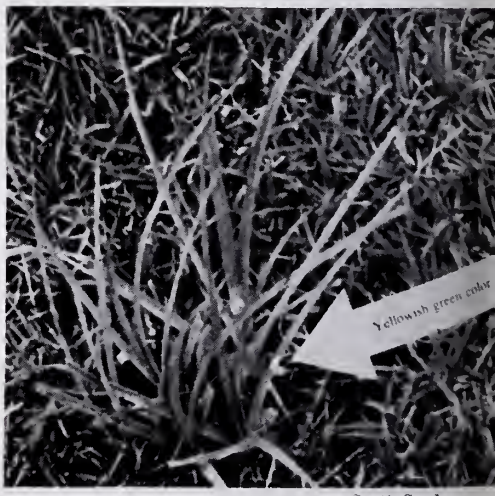
***Bermuda grass***

*2,4-D, 2,4,5-T, silvex*
Use on:
established broadleaf weeds
*DSMA, CMA, AMA*
Use on:
established annual grasses

***Centipede and Bahia grass***

*2,4-D, 2,4,5-T, silvex*
Use on:
broadleaf weeds
*Dacthal, Bandane, Azak, Betasan* or *Presan, Balan, Treflan*
Use to:
prevent germination of grasses. ♦

**Nutsedge (*Cyperus esculentus* or the introduced *C. rotundus*), also called nutgrass, is difficult to eradicate. Using weed-free soil for a new lawn is a preventive.**




*Scott Seeds*

# ELIMINATING CRABGRASS

## *Understanding plant's behavior helps in fight against it*

**J. M. Duich**

THAT most troublesome of lawn weeds, crabgrass, can be best controlled if the life cycle of the plant is understood. Both cultural and chemical methods can be used.

Two species, the hairy or large crabgrass (*Digitaria sanguinalis*), and the smooth or small (*Digitaria ischaemum*), are commonly found in turfgrass areas. Both are true annuals, but are often mistakenly confused with coarse, difficult-to-control perennials such as tall and meadow fescue, nimblewill, orchard grass, quackgrass and timothy.

Crabgrass begins its life cycle by germinating from seed in a period from mid-spring to late summer. All plants are killed by the first heavy fall frosts, but their seeds, in astronomical numbers, remain to perpetuate the weed. Flowering and subsequent set of seed in the finger-like heads takes place from midsummer on and may be produced at mowing heights as low as ¼ inch.

Crabgrass requires high light intensity and, once established, it will tolerate summer heat, compacted soils and dry soils better than most turfgrasses. Conversely, it will not survive shaded conditions produced by buildings, trees and shrubs or, most significantly, dense turf.

In general, crabgrass does not cause poor turf; poor turf results in crabgrass.

Because of the great number of viable seeds left in the soil from previous years of infestation, crabgrass cannot be totally controlled in one growing season. Complete control requires a conscientious program for several years, particularly if the soil surface is disturbed by aeration and dethatching machines. The basic principle of crabgrass control is to reduce seed production over several years so the viable seed supply in the soil will be diminished to a point where it is no longer a threat to the lawn.

### Cultural Control

Any management practice which increases the density, health and general vigor of the desirable grasses tends to discourage weed invasion through competition. Cultural crabgrass control practices are based on the principle of shading and crowding the young crabgrass seedlings by producing a dense sod.

Improper mowing is one of the major causes of weed invasion. Clipping a bluegrass or red fescue lawn less than 1½ or, preferably, 2 inches weakens the turfgrass.

Frequent light watering encourages the germination and development of crab grass at the expense of the turfgrasses. Watering only when turfgrasses show signs of wilting and then watering deeply, to a depth of at least 6 inches, is the best practice.

### Chemical Control

Chemical crabgrass control alone is not the answer to a quality lawn—it is just one valuable tool. It is not justified unless accompanied by an adequate management program designed to prevent crabgrass reinfestation or reversion to other lawn weed problems. *Successful and safe use of chemicals is possible only if the manufacturer's label is read carefully and the directions are followed explicitly.*

The chemical approach can be either pre-emergence (the use of chemicals to prevent emergence) or post-emergence (application of the herbicide to kill growing crabgrass plants after they have appeared in the turf).

#### *Pre-emergence Control*

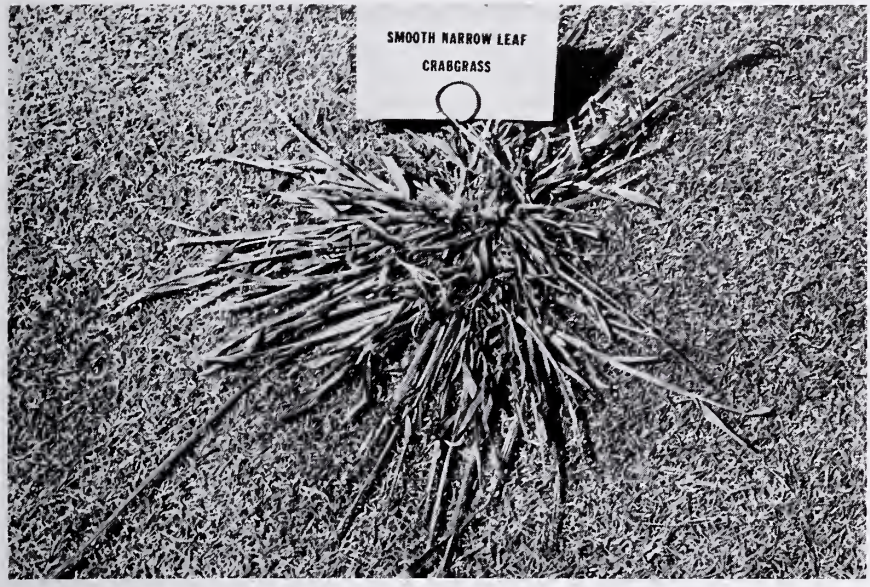
The greatest advances in recent years have been with the pre-emergence chemicals. They are insoluble and therefore remain near the soil surface for an ex-

Coarse and spreading, the thick growth of crabgrass *(Digitaria sanguinalis)* easily smothers the finer grasses of good turf. A rigorous campaign is needed to destroy it and to keep its many seeds from producing new plants.

## Pre-emergence Crabgrass Chemicals and Their Performance Characteristics

| *Chemical* | *Relative Control* | *Consistent Performance* | *Safe if Excess Used* | *Turfgrass Tolerance* |
|---|---|---|---|---|
| AZAK* | Excel. | Yes | No | Bluegrass only |
| BALAN* | Excel.-Good | Yes | Yes | Bluegrass only |
| BANDANE* | Fair-Good | No | Yes | All |
| BETASAN* OR PRESAN* | Excel. | Yes | Yes | All |
| CHLORDANE* | Fair-Good | No | Yes | All |
| DACTHAL* | Excel. | Yes | No | Bluegrass only |
| TUPERSAN* | Excel.-Good | Yes | Yes | All |

*Trademarked




**Though a smaller, finer-leaved plant than the large hairy-leaved crabgrass, shown opposite, *Digitaria ischaemum*, above, is an equally vicious pest. To keep it out of lawns, similar measures are required.**

tended period, killing crabgrass as it begins to sprout. They must be spread uniformly without skips before crabgrass germination. All types are available in dry form and can be applied with conventional spreaders, with or without fertilizer.

Crabgrass germination is governed by soil surface temperature and moisture, with occasional long delays due to drought. A simple index to follow for proper application date is to associate it with some common blooming shrub. *Apply pre-emergence crabgrass chemicals at lilac-blooming time.*

Kentucky bluegrass is the turf species most tolerant of pre-emergence chemicals; fine-leaved fescues (red and Chewings) and bentgrasses may be severely thinned by some of these materials. Injury to these more susceptible species is generally associated with older lawns and need of moisture for a prolonged period.

Chemicals which prevent crabgrass from appearing also affect desirable grass seed. Reseeding should be delayed for three to four months following their application. The sole exception to date is Tupersan. This chemical has a unique selectivity for crabgrass and similar annual weeds without injury to Kentucky bluegrasses, fescues and bentgrasses. Tupersan can be applied at seeding time to prevent crabgrass in new or reseeded lawns in spring and early summer.

The table opposite shows general performance and characteristics of pre-emergence chemicals available commercially. Materials are shown by trademark name. For chemical formula see package. The latter must be on the container label, whereas a trademark name is sometimes absent.

### *Post-emergence Control*

Successful use of post-emergence chemicals requires recognition of the weed at an early stage, for these weedkillers are most effective on young crabgrass plants that have not yet flowered. During a prolonged germination period, half a dozen treatments may be required. Such factors are contributing to the rapid decline of their use in favor of the more

Crabgrass *(Digitaria sanguinalis)* is one of the commonest and most easily recognized grassy weeds of lawns.

successful single-application pre-emergence treatment.

Because control becomes more difficult as the crabgrass plants mature, post-emergence applications should begin when they are quite young, in the three-leaf stage. Uniform coverage of infested areas is essential. Post-emergence chemicals discolor turfgrasses when temperatures are high and soil moisture low. Therefore, they should be applied only when the soil is moist and temperatures are below 85 degrees Fahrenheit, preferably in early morning or evening.

***Phenyl mercuric acetate*** (PMA) is the best chemical for controlling seedling crabgrass in May and early June, but it must not be used on lawns containing high percentages of Merion Kentucky bluegrass. PMA is effective only when crabgrass plants are in the two or three-leaf stage and when soil moisture conditions are adequate for normal growth. Because of successive germinations of crabgrass seed, it may be necessary to make three to seven treatments at 7- to 14-day intervals for control throughout the season. Liquid formulations of PMA generally are more effective than dry formulations. This chemical also possesses fungicidal properties and is therefore useful as well in controlling certain turfgrass diseases.

***Methyl arsonates*** may be used to control young and maturing crabgrass. Disodium methyl arsonate (DSMA) and amine methyl arsonate (AMA) are closely related compounds, available in many different concentrations in both liquid and dry forms. Liquid forms usually are more effective because they give more uniform coverage of infested areas. Both materials may cause severe discoloration of turf, especially fescues and bentgrasses. Research information indicates that AMA will kill crabgrass faster than DSMA. ♦

# GRASSES AS LAWN WEEDS

*Certain kinds, desirable in some situations, are considered pests in others*

**Elwyn E. Deal**

WHILE some perennial grasses are the chief components of high quality turf, others are among the worst of lawn weeds. Even some of the selected sorts can create serious weed problems if they are not being grown under the conditions to which they are best adapted.

The troublesome grasses are often introduced by poor seed mixtures* or poor sod or topsoil that contains seeds or plants of these grasses. The principal offenders, in addition to crabgrass, may be briefly characterized as follows:

## The Weedy Ones

***Bermuda grass*** (*Cynodon dactylon*) spreads by seeds, stolons and rhizomes, forming a sod which crowds out most other grasses. Improved varieties that form dense attractive sod are used extensively for turf in the warm southern regions to which they are best adapted. Bermudas are dormant and straw-colored during the fall, winter and spring, and may be killed by winter cold. They may be used to good advantage around summer homes, swimming pools and athletic fields, where there is little or no winter use. However, varieties with undesirable characteristics often appear voluntarily as aggressive weeds.

***Quackgrass or couchgrass*** (*Agropyron repens*) is a coarse, tenacious grass that produces an open thin sod and, by sending up new shoots from underground it crowds out almost all other grasses. Quackgrass spreads by rhizomes usually 2 to 8 inches deep, as well as by seed.

***Nimblewill*** (*Muhlenbergia schreberi*) usually grows in patches of light blue-green, and spreads by its numerous slender stolons as well as by seed. It invades poor turf much more readily than good thick sod. Nimblewill somewhat resembles Bermuda grass, and, like it, turns straw color in the fall.

***Tall fescue*** (*Festuca elatior arundinacea*) is a particularly objectionable perennial grass when it occurs in thin stands or is mixed with finer-leaved grasses. It is coarse, with wide, stiff blades that often grow horizontally and are sometimes difficult to cut with a reel-type mower. Tall fescue is a bunch grass but occasionally it produces a few weak rhizomes; thus it spreads very slowly if at all except by seed. It is usually introduced into lawns in ill-advised seed mixtures.

Because tall fescue is a tough, drought- and disease-resistant grass that tolerates considerable wear and other abuse, it is valuable for low-maintenance lawns where children play, also for athletic fields and other heavy-use areas. For these it *must* be seeded at a very heavy rate—4 to 6 pounds of tall fescue seed per 1,000 square feet, either alone or mixed with ½ to 1 pound of Kentucky bluegrass seed. The heavy seeding rate helps to prevent the clumpy appearance where it occurs only occasionally. It is also used extensively along roadsides and other areas where texture is less important than resistance to drought, disease and wear.

***Bentgrass*** (*Agrostis* species), like tall fescue, is looked upon with both favor and disfavor. It is a soft, fine-leaved grass. In addition to seeds, the creeping

*A new regulation of the U. S. Department of Agriculture requires that retail-size containers of mixed seeds intended for lawn or turf use be labeled to distinguish fine-textured grasses from coarse kinds, as an aid to the consumer who may not have knowledge of precise varieties.—ED.

*Scott Seeds*

Its bluish coloring makes nimblewill *(Muhlenbergia schreberi)* conspicuous in a lawn. Spot-treating of each plant as soon as it appears is a good way to get rid of it.

bents spread by stolons. Colonial bents do not have stolons but may develop a few weak rhizomes. Bentgrasses often appear voluntarily when lawns are watered lightly and frequently, and have been known to completely overcome solid bluegrass turf under such conditions.

These grasses are quite sensitive to heat and drought, they are affected severely by several diseases, and insects enjoy their tender leaves, especially in the southern region of their adaptation. Some bentgrasses, especially the Colonial or noncreeping types, are highly desirable in the northern states where summer growing conditions are favorable.

In more southerly regions bentgrasses usually become semidormant during summer, and in this weakened condition are more susceptible to injury. Here they should be used only on golf courses or other areas where their special requirements can be met with proper maintenance programs.

## Control Measures

### *Prevention*

One of the best ways to prevent these grasses from entering a turf area is to use grass seed of known composition. Since laws require that seed packages must be labeled accurately, this is easy. Each label shows the amount of weeds (usually negligible) as well as the proportion of each kind of grass seed in the container.

Topsoil used for filling and leveling uneven areas is a major source of nimblewill, Bermuda and quack-grasses. Quackgrass, particularly, is largely spread in soil or by seed blown from nearby weedy areas, rather than in commercial seed lots. Buying topsoil from reliable sources and personally inspecting it are two ways of avoiding this source of weeds.

Rough areas such as fencerows, vacant lots and unmown fields can also provide enough weed seeds to infest large areas. Grasses with stolons and rhizomes often spread into adjacent areas even without producing seed. Occasional mowing, along with some chemical control, is quite helpful in eliminating weed grasses from such areas.

Individual plants or small patches of tall fescue can be cut under the crown and removed by digging each plant or bunch of plants out of the turf, replacing it with new soil and seed or with sod. This is not feasible, however, with grasses like Bermuda and quackgrass, which have rhizomes, since even a small piece of plant left in the soil is enough to reinfest the area.

One is often tempted to "dig it all up and start over" but this would usually compound the difficulty. Disturbing soil creates good conditions for germination of new weed seeds, and each inch-long piece of rhizome can produce a new plant of the unwanted weed.

### *Herbicides*

Unfortunately, herbicides which kill weedy perennial grasses also kill bluegrasses, red fescues and most other grasses with which they come in contact. So far,

no selective chemical for killing these weedy grasses has been marketed.

Although not selective, there *are* herbicides that kill perennial grasses, and they can be sprayed on patches of the undesired ones. At least one of them, amitrole, is marketed for such spot treatment. It will kill most grasses to which it is applied, good as well as unwanted.

Sometimes it seems advisable to kill all grasses and start anew. Amitrole and dalapon are two of the best herbicides for this purpose. One to three treatments several days apart may be needed to completely kill the plants.

> Dalapon treatments should be started in late spring to allow time for the extra treatments and for the herbicide to disappear from the soil in time for early September seeding.
>
> Amitrole treatments can be started as much as two or three weeks later than dalapon since it does not persist as long in the soil.

### *Soil Sterilization*

Methyl bromide, a soil fumigant, is extremely effective in killing plants and plant parts, including seed. It will also kill insects and some diseases in the soil. This chemical must be covered and sealed with an air-tight cover such as plastic or polyethylene film for 24 to 48 hours after application. It acts by vaporizing in the soil. *Methyl bromide should be applied only by an experienced professional person* because this colorless, odorless chemical is highly toxic to man and can be hazardous to animals and other plants.

### *Cultural Practices*

A thick, healthy, vigorous and fast-growing turf is one of the best means of preventing undesirable grasses from invading lawns. Unfortunately, once a good turf has become established, almost every cultural practice that favors bluegrasses and fine fescues is also beneficial to the weedy perennial grasses.

Nimblewill is the poorest competitor among this group and can be discouraged from spreading if the desirable grasses are encouraged.

Bermuda, the only warm-season species in the group, may be somewhat held in check at its northern limits if the cool-season grasses such as bluegrasses and fescues are heavily fertilized in fall and early spring. Summer or even late spring fertilization definitely favors Bermuda grass.

In summary, the best way to cope with nimblewill, tall fescue, Bermuda, quack- and bentgrasses is to eliminate them completely as soon as they invade the turf. This can be done by hand weeding tall fescue or spot treating the other grasses with chemicals such as dalapon or amitrole. ♦

*Scott Seeds*

**Tall or coarse fescue (*Festuca elatior arundinacea*) is best removed from turf by digging out each plant and replacing it with sod or with soil and lawn seed.**

*Herbicides eliminate back-breaking labors of weeding*

# GARDEN ANNUALS

**Chiko Haramaki**

WORKING in a quiet, verdant garden is among the day's pleasantest activities, but when weeds, the bane of gardeners everywhere, are omnipresent, pleasure comes to an end. Since weeds compete with garden plants for sunlight, soil nutrients, water and space, the plants become stunted and the garden appears ill kept. The thought of constant weed pulling and hoeing deters many who are potential gardeners.

The logical way to enjoy gardening more by weeding it less would be to start with a soil that is free of both weeds and weed seeds, but this is more easily said than done. Many gardens are kept relatively clean through the constant vigilance of the owner in weeding, mulching and cultivating to prevent the weeds from producing seeds. Mulches are a special help for they retard weed growth and they also improve water retention and stabilize soil temperature.

Much of the tedious backbreaking work of hoeing and weed pulling can be eliminated through use of some of the newer herbicides. While the large number of varieties of annual garden flowers complicates the problem of finding a herbicide which can be safely used on the many different kinds, there are a number which provide adequate weed control with little or no injury to the annual flowers. It is important to apply them at the correct time and concentration. So far, only a few are available to the home gardener in a conveniently small package. The others have to be purchased through farm or nursery supply houses.

In general, the herbicides can be applied either before or after transplanting bedding plants. Here are the directions:

***Before transplanting.*** The soil should be rototilled or well spaded and the number of square feet determined. Next the correct amount of herbicide is measured and mixed with a sufficient amount of water to spray or sprinkle on the measured area. The herbicide should be immediately incorporated into the soil by either rototilling or some other method which insures good mixing.

Generally it is desirable to wait about a week before transplanting. The transplants should have a ball of soil around the roots at the time of planting.

Herbicides which have been satisfactorily used as pre-transplant weedkillers include **EPTC, SMDC, trifluralin,** and **vernolate.**

***After transplanting.*** Wait a few days after setting out transplants before applying weed killers. The soil should be clean cultivated or hoed immediately before herbicide application. The area to be treated should be determined in square feet and the correct amount of herbicide weighed out. If the herbicide is a wettable powder it should be mixed with a sufficient amount of water to spray the measured area. The herbicide should be applied to the soil and not to the plants.

If granular materials are used, do not apply when the foliage is wet. Granular herbicides can be purchased by the home gardener in containers resembling large salt shakers.

Since it is extremely important that the correct amount of herbicide be applied to a given area, manufacturers often give clear diagrams or instructions on proper applications in both amounts and methods. There may be an illustration on the package indicating the spacing of the particles for the correct rate of application, or graduations along the side of a translucent plastic container indicating the quantity to apply over every ten square feet.

*(Concluded on page 30)*

# Suggestions for Chemical Weed Control in Garden Beds

| Herbicide | Treatment | Remarks* |
|---|---|---|
| PRE-TRANSPLANT | | |
| EPTC (Eptam 6E) or vernolate (Vernam 6E) | 6 tablespoons of 6E in 3 to 10 gallons of water per 1,000 square feet. Apply with a sprayer or sprinkling can. | Immediately incorporate into the soil by rototilling to a depth of 2 to 3 inches. Transplant 7 to 10 days after treatment. Has been successfully used on aster, dahlia, marigold, petunia and zinnia. Impatiens, scarlet sage, and snapdragons are not tolerant. Will control most annual and some perennial weeds. |
| trifluralin (Treflan 4E) | 3 tablespoons of Treflan 4E in 3 to 10 gallons of water per 1,000 square feet. Apply with a sprayer or sprinkling can. | Immediately incorporate into the soil by rototilling to a depth of 2 to 3 inches. Transplant 5 to 7 days after treatment. Broad plant tolerance. Used successfully on ageratum, aster, dahlia, impatiens, marigold, ornamental pepper, petunia, scarlet sage, snapdragon, and zinnia. Portulaca not tolerant. Will control most annual weeds. |
| POST-TRANSPLANT | | |
| amiben (Garden Weeder) | 6 pounds of Garden Weeder per 1,000 square feet. Sprinkle from container. | Apply to bare soil immediately after weeding and cleaning up beds of perennials. Allow two weeks between setting out transplants and treatment. Do not use on seeded flowers before they emerge. Used successfully on aster, chrysanthemum, dahlia, daylily, iris, marigold, peony, petunia, snapdragon, and zinnia. Will control most annual weeds. |
| DCPA (Dacthal 50W) | 10 to 12 ounces of Dacthal 50W in 3 or more gallons of water per 1,000 square feet. | Spray the soil 2 to 3 days after transplanting. Most annual flowers are tolerant. Will not control sprouted weeds. Reapplication necessary after 5 weeks. |
| dichlobenil (Casoron 50W) | 3 to 4 ounces of Casoron 50W in 3 or more gallons of water per 1,000 square feet. | Spray the soil 5 to 7 days after transplanting. Many annuals are tolerant such as ageratum, celosia, marigold, petunia, portulaca, scarlet sage, snapdragon and zinnia. Most annual weeds controlled. |
| diphenamid (Dymid 80W or Enide 50W) | 1½ to 3 ounces of Dymid 80W, or 3 to 4½ ounces of Enide 50W, in 3 or more gallons of water per 1,000 square feet. | Spray the soil 5 to 7 days after transplanting. Many annuals are tolerant such as marigold, petunia, scarlet sage, snapdragon, and zinnia. Most annual weeds controlled. |

*The area to be treated should be clean, cultivated or weed free. Adequate soil moisture is also necessary at the time or immediately following treatment.

*Fumigation, cultivation, mulching, herbicides, all help in weed control in*

# PERENNIAL PLANTINGS

## Arthur Bing

HOW can one keep ahead of weeds that hide fine perennials, compete with them, and harbor pests?

The simplest method is to select a relatively weed-free area for growing perennial flowers—one that is clear of such perennial pests as nutsedge, quackgrass, thistle and mugwort. Before the final choice, observe the plants that grow in the soil for a season before planting. A little effort in selecting soil saves work later.

If none of the soil available is reasonably weed-free, one should consider treating it in advance of planting. Frequent cultivation of a crop-free soil the season before planting helps eliminate long-lived weeds. Fumigating with Vapam at least three weeks before planting exterminates most weeds (except purslane) and also controls nematodes and some diseases. The procedure:

> *For detailed instructions, read the directions on the container.*
>
> When the soil is moist and has a temperature of at least 50 degrees Fahrenheit, either spade and rake it, or rototill it to a depth of 6 to 8 inches. Mark the area into 10- by 10-foot plots.
>
> Before handling Vapam, put on rubber gloves; be careful not to touch the chemical. If any gets on the skin, wash promptly. Be careful not to get the chemical in or on leather shoes.
>
> Put 1 quart of Vapam into a watering can, fill with water and stir (the odor is foul).
>
> Apply this solution evenly to a 10- by 10-foot area, then water it until the Vapam solution has soaked down to 6 inches.
>
> Repeat this treatment on each 100-square-foot area.

It takes about three weeks for the chemical to escape from the soil so that planting may be safely undertaken.

### Mechanical Control

There are several other reliable (but not always desirable) methods of weed control. *Pulling by hand* is one method, if the area is small and the weeds pull easily, but curly dock, dandelion and many others have tap roots that grow very deep, so often only the top is removed; later new shoots develop.

*Cultivation* keeps soil surface dry, thereby killing young weeds and preventing germination of small seeds near the surface. If this is done while weeds are small, hand pulling will be unnecessary. In cultivating, take care to avoid damaging roots of nearby trees, shrubs and other plants.

*Mulching the soil* will hold many weeds in check. An ideal mulch allows free passage of moisture and air, yet smothers the growth of young weeds and prevents germination of seeds that require light. It should not decompose readily, not be easily blown by the wind, not in itself be a source of weed seeds, and not be expensive. Among the good mulching materials are pine bark, cocoa hulls, buckwheat hulls, poultry grade lumpy peatmoss and salt hay.

Mulches have a moderating influence on soil temperature and help retain soil moisture. They can, however, harbor field mice and promote growth too late in the fall. For control of annual weeds, 2 or 3 inches is sufficient. Perennials such as quackgrass may come through a thin mulch and require hand pulling. For such, a deeper covering is necessary.

*Opaque black plastic and paper films* are used commercially for weed control but may be difficult for the home owner to apply and do not look attractive. Plastic films are often used under other mulches to intensify their effects.

## Chemical Control

Certain chemicals can be applied to the soil around perennials to discourage weed growth without hurting ornamental plants themselves. On most perennial plantings, Dacthal granular can be used safely against annual weeds, but it will not control perennial weeds. It should be applied to the soil before weed seeds germinate. The same is true of Sesone, a chemical which becomes active only upon contact with the moist soil.

The job is simplest where there is only one kind of perennial in a planting. It is harder where there is a wide variety of flowering plants because many react quite differently to the herbicides that might be used. The situation can be further complicated by the range of weeds to be controlled, especially if they, too, are perennials.

Chemicals can be expected to have the desired effect only if they are applied uniformly at the proper rate. Unequal distribution can cause plant injury in one area and poor weed control in another. Every effort should therefore be made to cover the ground evenly. Also, every effort should be made to keep the herbicide off the foliage of ornamental plants.

The success of any procedure used to control weeds depends on timing the operation to get the greatest benefit from the treatment. Specific weed-control practices for four widely planted perennials are given below.

### *Gladiolus*

If soil fumigation before planting is desired, the Vapam treatment described earlier can be used. It is best carried out the autumn previous to spring planting.

Where gladiolus are being grown in rows, after setting the corms in the furrow, cover them so as to leave a hill of soil. Raking this down part way after a few days (well before the glads come up) removes the first crop of weeds. After a few more days, add a pre-emergence herbicide, preferably after the soil has been compacted by rain or irrigation.

Half-a-dozen chemicals that could be used at this stage, and some for post-emergence application as well, are described below. Specific directions and

(*Please turn page*)

## Herbicides Suggested for Trial Use on Gladiolus

| Material* | Pounds Actual Per Acre Pre-emergence | Post-emergence | Rates of Commercial Material** per qt. for 100 sq. ft. |
|---|---|---|---|
| Chloro IPC (4 lb/gal) | 6-8 | | 3-4 teaspoons*** |
| Chloro IPC 5% granular (1 measuring cup = 1/3 lb.) | 8 | 8 | 3/8 lb. or 6 oz. wt. (dry) |
| Sesone (90% W.P.) | 4-6 | | 2½-4 teaspoons |
| Dacthal 50% W.P. | 10-15 | 10-15 | 2/3-1 oz. wt. |
| 5% granular | 10-15 | 10-15 | ½-2/3 lb. (dry) |
| Dinitro 10% granular (1 measuring cup = 1/3 lb.) | 6-8 | 4-6 | 2-3 oz. wt. (dry) 1½-2 oz. wt. (dry) |
| Treflan (4 lb/gal conc) | 1-2 soil incorp. 4 watered in | | ½-1 teaspoon 1½ teaspoons |
| Vapam | | | 1 qt. (watered in) |

*All materials except dinitro should be applied before weeds are up or at least are less than ½ inch high.

**Follow manufacturer's directions. Rates are given for commercial material. For granular formulations no water is used.

*** 3 teaspoons = 1 tablespoon
16 tablespoons = 1 cup
2 tablespoons = 1 fluid ounce
4 cups = 1 quart

measurements are given in the accompanying table.

*Chloro IPC*, liquid or granular, is fairly effective against seedling weeds, especially grasses. It is used in the same manner and is effective for the same period as dinitro (described below).

*Sesone* has been used by several gladiolus growers but is effective for only four to six weeks. Because it is quite soluble, leaching by heavy rain can occasionally cause injury. To avoid this, mound the soil slightly around the plants so that with heavy rain the chemical will tend to wash away rather than down on the roots.

*Dacthal* used on a moist soil surface before gladiolus or weeds are up gives good safe weed control.

*Dinitro* 10% granular is a safe weedkiller for most varieties of gladiolus. It is effective for six to eight weeks and can be reapplied (post-emergence) after eight weeks or just before flower spikes emerge by using a lawn fertilizer spreader mounted on 3-foot wooden wheels or by using a Cyclone or Seymour type spreader between the rows. Dinitro is most effective on broad-leaved weeds; it will not control perennial grasses. Dinitro spray is not recommended because the fumes could easily injure other garden plants, especially columbine, delphinium and cabbage. A few gladiolus varieties may also be sensitive to it.

*Treflan* sprayed on the soil after planting gladiolus and incorporated immediately in the top inch of soil by rototilling has given good weed control, especially of grasses.

### *Iris*

*Chloro IPC* granules have been used to control annual weeds in iris with no injury. The 5% granules are used at a rate of 3 pounds per 1,000 square feet. Chloro IPC gives good control of spring and winter weeds such as chickweed and annual bluegrass and of purslane in the summer. It will not control perennial weeds.

### *Daylily*

*Treflan* incorporated into the soil controls annual grasses and most broad-leaved weeds. The liquid is sprayed on the soil and then raked into the soil or watered into the top inch. It should not touch the daylily foliage.

### *Peony*

*Dacthal* and *Chloro IPC* are safe and will control many annual weeds in peony plantings. For the peony specialist *simazine* at a low rate (2 to 4 pounds of active ingredient per acre, 1 to 2 pounds of 4% granular per 1,000 square feet) is safe on most varieties. It should be applied in the fall, and not followed by further simazine treatments the next year. ♦

## GARDEN ANNUALS

(*Continued from page* 26)

Some herbicides which have been satisfactorily used on established annual flowers include **amiben**, **DCPA**, **dichlobenil**, and **diphenamid**.

The effectiveness of herbicides in the home garden is influenced by a number of factors such as adequate moisture for weed seed germination, clean cultivated soil, light, temperature, soil micro-organisms, concentration and so on. It must also be remembered that soils with a high organic or clay content tend to tie up the herbicide, so a larger quantity is needed, while sandy soils require less.

The accompanying chart (page 27) provides some suggestions for the home gardener in reducing the number of weeds in his garden. ♦

*Precise techniques required for weed control in*

# WOODY ORNAMENTALS

J. R. Havis

WEEDS are no ornaments in ornamental shrub plantings, and they are robbers of water and plant nutrients. The least popular ways of removing them are hand pulling and hoeing.

Mulches of various sorts offer a much more satisfactory means of solving the problem. Organic materials, as peat, leaves, lawn clippings, wood bark, wood chips, shavings, pine needles and shredded sugar cane are most commonly used. To prevent the growth of most weeds, they need to be 2 to 3 inches deep.

Mulches provide several important benefits in addition to weed control. They help conserve moisture, prevent soil compaction and erosion, aid in water penetration and root aeration, and reduce soil temperature fluctuations. The few weeds that penetrate a properly applied mulch can be readily removed by hand. Herbicides can be used with mulches, but there is generally little need for them.

In situations where mulching is not feasible, however, certain herbicides are safe to use. Their safety is governed by the rate of application and this is difficult to figure on the usual size and shape of areas used in landscape plantings. Rates have been worked out for nurseries, where plants are grown in rows in large, straight-sided unit areas, but calculation of the square feet of area to be treated in curve-sided plantings is difficult. However, *it must be done* before the use of herbicides is attempted.

A 1- to 3-gallon hand sprayer can be used for spraying herbicides. A "weed control" type nozzle, which delivers a flat spray, is best. The proper amount of herbicide should be mixed in about 1 gallon of water for each 1,000 square feet, and the application should be made as uniformly as possible over the soil surface.

Granular herbicides should be weighed carefully to obtain the correct amount for the size of area to be treated. On large areas, granulars may be spread with a "cyclone seeder" type of applicator. Small amounts may be applied by shaking through holes punched in the lid of a coffee can.

## Herbicides for Control of Annual Weeds

*For application in spring or summer*

The following pre-emergence herbicides are to be applied to weed-free soil, such as at the time of setting plants or after clean cultivation. They are not toxic to plant foliage, but must be distributed evenly over the soil.

**Trifluralin** (Treflan*) must be mixed with the upper 1 to 2 inches of soil immediately after application. This mixing can be done with a rake or with a rotary tiller if the treatment is being made before planting. If the treatment is being made around established plantings, the herbicide may be raked or hoed into the soil surface.

For liquid spray:
- On light sandy soils—1½ ounces Treflan* per 1,000 square feet
- On heavy or high organic matter soils—up to 3 ounces per 1,000 square feet

Dry granular application:
- On light sandy soils—2 pounds of the 2½% formulation per 1,000 square feet.
- On heavier soils—up to 4 pounds per 1,000 square feet

**Diphenamid** (Dymid* or Enide*) need not be mixed with soil, but weed control is improved by at least ½ inch of rain or irrigation (hose watering). It does not control yellow wood sorrel or ragweed.

For liquid spray:
- On light soils—3 ounces of Dymid* per 1,000 square feet

*Trade name. *Note:* Trade names are used here solely for clarity. No endorsement is implied nor is discrimination intended.

On heavy soils—up to 5 ounces per 1,000 square feet

Or, Enide 50% wettable powder—3 to 5 ounces per 1,000 square feet

Dry granular application:

$2\frac{1}{2}$ to 3 pounds Enide* 5% formulation per 1,000 square feet

**Dacthal*** is not to be mixed with the soil, but should be wet down with at least $\frac{1}{2}$ inch of rain or irrigation. It does not control ragweed or smartweed well.

For liquid spray:

5 ounces of 75% wettable powder per 1,000 square feet

For dry application:

10 pounds 2.5% granular per 1,000 square feet

### *For application in autum to control winter annual weeds*

**Diphenamid** (Dymid* or Enide*) or **Dacthal*** may be applied as described above around established plants immediately after removing all existing weeds in September or October. The purpose is to prevent the growth of such winter annuals as chickweed and annual bluegrass in the fall and early spring.

Adding $\frac{1}{3}$ to $\frac{1}{2}$ ounce of 80% simazine wettable powder per 1,000 square feet to the amount of either diphenamid or Dacthal liquid spray given above improves weed control markedly.

## Control of Perennial Weeds

**Quackgrass** (*Agropyron repens*) spreads by underground rootstocks and regenerates readily after tops are removed. Since ornamental plantings are usually invaded from adjoining patches, it is wise to attack the source of infestation as a preventive measure. Quackgrass growing a few feet from valuable plants can be treated with Amizine* or dalapon (Dowpon*) applied to actively growing grass as directed on the container.

> **Casoron*** 4% granules may be spread over quackgrass at the rate of $3\frac{1}{2}$ pounds per 1,000 square feet (5 to 6 ounces per 100 square feet) during a cold season of the year—in late October or November, or in February or early March. The granules should not be applied up-hill from lawns, flowers, shrubs, or any crop area because heavy rain could wash it down-hill and injure sensitive plants below.

When quackgrass is growing in the ornamental planting, hand removal is probably the only safe answer. A 3-inch mulch can be surprisingly helpful. Although the grass will push through the mulch, after one season most of the rootstocks will be immediately under the mulch, so hand removal becomes a simple matter.

**Mugwort** (*Artemisia vulgaris*) has become a serious problem in some nurseries and is being transferred into landscape plantings. Once established, it is very difficult to eradicate because of its ability to regrow from underground rhizomes.

> In late fall or early spring *only*, Casoron* 4% granules at 3 pounds per 1,000 square feet (5 ounces per 100 square feet; $\frac{1}{2}$ ounce per 10 square feet) can be used on patches of mugwort.

This suggestion is made with the assumption that eliminating the persistent weed is worth some risk of damage to the ornamental plants. If such risk cannot be tolerated, then thorough and persistent digging is the only solution.

**Bindweed** (*Convolvulus arvensis*) and similar deep-rooted entwining perennials (such as *Convolvulus sepium* and *Polygonum convolvulus*) are quite sensitive to 2,4-D, which is commonly used to control weeds in lawns. But most ornamentals are also damaged by 2,4-D, therefore this herbicide is not usually suggested for such use. Never spray bindweed while it is still entwined in the branches of other plants.

> If the vines can be removed from the plants, the stems and leaves that are still attached to the root, and new sprouts, may be painted or wiped with 2,4-D solution. Wands with 2,4-D, intended for individual treatment of dandelions, should be useful for confining the applications. ♦

*Several herbicides hold weeds at bay in*

# SWEET CORN

Charles J. Noll

CORN is sweetest when cooked within minutes after being picked, and its quality is best in a garden kept free of weeds.

In the past, the home gardener had to rely on hand-weeding to keep his vegetable plot clean, but now he can apply herbicides of the same sort that commercial growers use. He has been slow, however, in accepting chemical weedkillers, because of the great number from which to choose, the possible need for special equipment, the complications involved in figuring rates of application in a small area, and the numerous precautions necessary. For example, chemicals used for weeding carrots would kill beans, those used on beans would kill tomatoes, and the kinds applied to tomatoes would injure corn. Furthermore, if too little chemical is applied, weeds are not destroyed; if too much, this crop or another may be damaged.

The list of herbicides that may be used to weed sweet corn includes such chemicals as 2,4-D, DNBP, atrazine, simazine and others that may be applied separately or in combination. Some of these chemicals are specific in action: 2,4-D kills broadleaf weeds but scarcely troubles grasses; DNBP kills weeds that have emerged at time of treatment but has little effect on weeds that appear later. Some chemicals are used to kill specific weeds, such as quackgrass and nutsedge (commonly called nutgrass). These may have to be applied by incorporating them into the soil before the corn is planted.

One of the safest and easiest of herbicides to use on corn is *atrazine*, which will kill most weeds, both broad-leaved ones and grasses, without injury to the sweet corn. The few that do not respond can easily be removed by hoeing. Being a wettable powder, atrazine is easily mixed with water but needs to be stirred or shaken occasionally to keep the powder in suspension. It can be applied with a knapsack sprayer or even a sprinkling can. Afterward, the applicator can be cleaned by simply rinsing it with water; atrazine does not contaminate it.

Atrazine can be applied from time of planting until corn is through the ground, but preferably soon after seeding. A long delay may result in poor weed control, especially of crabgrass. The amount of water used with it is unimportant as long as the powder remains well mixed and the application is reasonably uniform.

> For every 75 square feet of soil 1 level teaspoonful of atrazine is recommended. This means 3 teaspoons, or 1 level tablespoon, for 225 square feet. That is, three 25-foot rows of corn planted 3 feet apart would receive 1 tablespoon of atrazine in water.

More than that amount might leave a residue in the soil that would damage another vegetable crop the next year. Atrazine injures all vegetables except corn. It may even make a grass cover crop difficult to establish in the garden right after harvesting.

With proper application, however, there should be no chemical remaining in the soil by next spring's planting time. As with many other herbicides, atrazine is eventually destroyed by soil organisms. However, it is advisable to turn over the soil in the fall to further distribute and expose the particles. This will assure their decomposition. ♦

*Three ways of keeping weeds away from*

# TOMATOES

J. C. Cialone

As with most long-season crops, weeds can be a serious problem for tomatoes. Annual weeds are more common than perennial ones, and of these, grasses probably annoy tomato growers most, since they are difficult to pull by hand or to cultivate out after they have become established. In home plantings, weeds can be kept from competing with the tomatoes through cultivation, mulching or the use of herbicides.

## Cultivation and Hand Weeding

In small gardens, it is probably most practical to hoe weeds out or to cultivate the soil by hand. It is always important to catch the weeds when small, while they are still easy to kill and before they start affecting the crop.

Overtillage must be avoided. Cultivating constantly to achieve a freshly worked appearance in the soil can damage the crop seriously for it prunes crop roots and thus reduces plant growth; it also increases loss of moisture from the soil.

## Mulching

Mulching tomatoes and other garden crops affords several benefits and is easy to accomplish. Straw, sawdust, peatmoss, wood chips, aluminum foil and other materials can be used as mulches.* A newer one which makes an excellent mulch is black polyethylene film. This material conserves moisture, heats the soil, prevents leaching of fertilizer and packing of soil, eliminates root pruning by cultivation, and effectively controls weeds. Several steps are involved in the successful use of polyethylene mulch:

1. Apply fertilizer and work it into the well prepared soil before planting.
2. Have the soil moist, though not excessively wet, before putting on the mulch sheets.
3. Dig shallow trenches, about 36 inches apart, along the ends and sides of each row area.
4. In laying down the polyethylene sheets, place one end in the trench at the end of the row and cover about 6 inches of it with soil. Pull the sheet taut across the row. Then bury the other end and the sides in the trenches prepared for them, keeping the sheets always as taut as possible.
5. Cut holes about 3 inches in diameter at desired intervals for planting. A bulb planter is handy for accomplishing this; when it is pushed through the plastic with a sharp stroke, it cuts a round hole and also removes soil where the plant is to be set.
6. If it has been necessary to install the plastic when the soil is dry, water the plants well when they are set in place or they may not have enough moisture for rooting.

Polyethylene mulching has worked very well for both ground and trellis tomato culture, as well as for growing many other garden crops. It maintains weed control in the crop row successfully throughout the season. Hand hoeing, cultivation, or chemical control is necessary only between strips of plastic.

For many garden situations, this type of mulching may well be the most practical method of controlling weeds in tomatoes.

## Herbicides

For the large tomato planting, chemical weed control can be both practical and effective; however, a number of problems must be considered.

*For complete details see the Brooklyn Botanic Garden's Handbook on Mulches.—Ed.

In selecting a herbicide for tomatoes (or any other garden crop) it is necessary to choose a chemical that has government approval for use on several food crops. Tomatoes, for instance, are extremely sensitive to 2,4-D and related compounds. Equipment used for 2,4-D type materials should never be used for applying *anything* to tomatoes (or to most other garden plants). In general, herbicides are quite specific in terms of the plants on which they are safe and the weeds which they control.

Listed below are several chemicals which have government approval for use on tomatoes. The best for any particular area will vary according to the weed species present and other local factors.

## Suggested Chemicals for Weed Control in Tomatoes

| *Chemical* | *Formulation* | *Application* | *Comments* |
|---|---|---|---|
| Amiben | Granule only | 3 to 5 days after transplanting, to clean, freshly-worked soil. Do not apply when foliage is wet. | Best if application is followed by rain or irrigation. About ½ inch of water sufficient to move chemical into upper soil layers where most weeds germinate. |
| CDEC | Spray or granule | Immediately after transplanting, to clean, freshly-worked soil. | Follow with irrigation as above. |
| Diphenamid | Spray or granule | Immediately after transplanting, to clean, freshly-worked soil; can also be applied immediately after sowing seed. | Follow with irrigation, as above. Since diphenamid remains effective in soil for several months, crops for which it is not approved should not be planted sooner than 6 months later. |
| Trifluralin | Spray | Just before transplanting; mix *thoroughly* with top 3 to 5 inches of soil. | Rainfall is not essential for maximum activity. |

No attempt has been made to give specific recommendations for application rates, since local variations in soil, climate, et cetera, determine which chemical and dosage are best for a given area. It is recommended that this information be obtained from a county agent or other local weed control authority.

It must be stressed that anyone using chemical methods of control should *read and follow package label directions very closely.* When handled properly, herbicides can be helpful tools in the control of weeds. But the greatest of precision and care are required for the protection of the crop. ♦

*Cultural methods and herbicides spell success for*

# ASPARAGUS

E. M. Rahn

DURING the cutting season, which lasts about seven weeks in spring, it is difficult to find the spears if weeds have been allowed to grow in the asparagus bed. Moreover, the spears will not be as stout and succulent as if they had been grown in neat, clean rows where weeds did not offer competition for moisture and nutrients for the plants. Later, during the "fern" or foliage stage, if weeds are still uncontrolled, diseases such as rust and Cercospora blight are more likely to be serious. This is because when weeds are thick there is not enough air to allow morning dew to evaporate quickly from asparagus, and the long-continued moisture gives disease organisms an excellent opportunity to invade the crop.

Three weed-control methods are open to the asparagus grower: cultivation alone, herbicides alone, or a combination of the two. But first, as soon as soil can be handled in spring, winter weeds and the dead tops of last year's asparagus should be worked into the soil. This can be done by hoeing (or by disking or rototilling)—but not so deeply as to injure the asparagus crowns.

## Control by Cultivation

If weeds are to be controlled by cultivation alone, hoeing (or mechanical cultivation) is needed whenever they get about 1 inch high. Soil is thrown over the row as weeds are uprooted, so that after a few cultivations a ridge of earth is formed where the asparagus is growing. One advantage is that in hot weather, ridging causes asparagus spears to be thicker, though somewhat fewer.

Cultivation has some adverse effects on asparagus, however, for severing of asparagus roots and shoots can scarcely be avoided. Usually, five to seven days of spear production are lost after each cultivation. With hand work in the home garden, however, this figure might be reduced.

At the end of the cutting season, some growers cultivate the asparagus bed again to get rid of weed growth and to break down the ridges. Occasional hoeing will again be necessary as the asparagus develops its ferny foliage during the remainder of the growing season.

## Control by Herbicides

If weeds are controlled by herbicides alone, brands that provide long-term control are necessary. Several recommendations are given below. If the early-season cultivation is *not* practiced, the overwintering dead asparagus ferns must be cut off and carried away before spring growth begins.

In no case should a herbicide be used that does not list *asparagus* on the label. Furthermore, the specific directions on the label for use on asparagus should be followed carefully to insure not only good weed control without crop injury, but also the absence of harmful residue on or in the asparagus spears.

The chemical a particular gardener uses on his small asparagus planting will be largely determined by which one is available in small packages in his area. Since the amount needed will usually be just a few tablespoons, a home gardener is not inclined to purchase a product offered to commercial growers in a 10- or 50-pound bag.

## Combination Method

If weeds are controlled by a combination of cultivation and herbicides, the spring hoeing (or mechanical cultivation) is followed by one or two additional cultivations two or three weeks apart. These are made in order to build up a ridge as

well as to eliminate weeds. Later-appearing weeds are kept under control with a herbicide.

## Application of Herbicides

***Simazine 80W.*** For full-season control with one application:

> Mix 3 level tablespoons of chemical in 1 gallon of water. Apply this amount to 1,000 square feet in spring before asparagus spears and weeds have emerged.

For weed control with two applications:

> Reduce the amount of chemical by one-half. Make the second application at the end of the cutting season.

*Do not use the first season after planting the crowns.*

***Telvar (monuron) 80W.*** Follow all directions given for Simazine 80W. A Telvar spray may also be applied during the cutting season, but for effective control the weeds should not be more than ½ inch high.

***Sesone.*** Use in spring before asparagus spears and weeds have emerged. For weed control during the foliage or "fern" stage, repeat in midsummer after the cultivation that follows the cutting season.

> Dissolve 2¼ level tablespoons of sesone in 1 gallon of water and apply this amount to 1,000 square feet.

***Alanap-3.*** Use in spring just after cultivating, in summer at the end of the cutting season, and again after the subsequent cultivation for control of weeds after the asparagus foliage has developed.

> Mix ½ pint of Alanap-3 in 1 gallon of water and apply this amount to 1,000 square feet.

***Dowpon (dalapon).*** For application either before or during the cutting season or when asparagus is in the foliage stage. During the cutting season use Dowpon *only immediately after cutting.* During the "fern" stage, direct the spray on the soil *under* the asparagus foliage.

> Dissolve 3 level tablespoons of Dowpon in 1 gallon of water and apply this amount to 1,000 square feet.

Dowpon is particularly effective on grasses that have emerged from the ground, but it will also inhibit broadleaf weeds. If perennial grasses such as quackgrass or Bermuda grass are present, ½ cup of Dowpon should be used in 1 gallon of water.

***2,4-D.*** Only the sodium salt of 2,4-D is approved by the U.S. Department of Agriculture for use on asparagus. It is best applied in spring just after cultivating and again at the end of the cutting season, also after cultivating. If used during the cutting season, no more than two applications should be made, spaced at least one month apart. The spray should be applied only after a close cutting, for any spears hit by the 2,4-D would be deformed. If applied during the foliage stage, the spray should be directed to the soil to avoid plant injury.

> Dissolve 1½ level tablespoons of the sodium salt of 2,4-D in 1 gallon of water, and apply this amount to 1,000 square feet.

If this herbicide is applied *before* weeds emerge, control of both annual grasses and annual broadleaf weeds should result. If used *after* weeds have emerged, only the broadleaf weeds will be killed; the grasses will not be affected. ♦

*Tillage, mulches, chemicals keep soil weed free among*

# VINE CROPS

J. D. Long

VINE crops, as the cucurbits are called, are plagued by weeds from planting time until harvest. The trailing habit of the cucumbers, squashes, pumpkins and melons, also their easily injured succulent foliage, make weed control difficult. Three methods of handling the problem—tillage, mulches and chemicals—are described below.

### Tillage

*Prepare a good seedbed* that leaves loose dry soil on the surface with moisture below. If possible, schedule the planting when the weather is warm and rain is not likely for several days. This allows the tender seedlings to emerge rapidly. As the plants develop, several shallow cultivations to keep the soil surface loose and

## Chemicals for Use on Vine Crops at Planting Time

| Chemical | Rate (*teaspoons per 100 square feet sprayed*) Sandy Soil | Clay Soil | Crops | Comments |
|---|---|---|---|---|
| Alanap-3 (2 lb. per gal.) | 1¾ | 3½ | Cantaloupe<br>Cucumber<br>Pumpkin<br>Squash<br>Watermelon | Difficult to remove from sprayers—requires thorough washing with ammonia and detergent. Stunting may occur in wet cold weather. |
| Vegiben (2 lb. per gal.) | 1¾ | 3½ | Pumpkin<br>Squash | Heavy rains may reduce effectiveness in light soils. |
| Vegadex (4 lb. per gal.) | 1 | 1¾ | Cantaloupe<br>Cucumber | Heavy rains soon after may result in injury. |

*These herbicides perform best if they are applied to freshly worked soil immediately after planting. Sprinkler irrigation (½ inch) should follow then or within a few hours.*

## Chemical for Use 4 to 6 Weeks after Planting

| Chemical | Rate (*teaspoons per 100 square feet sprayed*) Sandy Soil | Clay Soil | Crops | Comments |
|---|---|---|---|---|
| Dacthal (75% wettable powder) | 1 | 1¾ | Cantaloupe<br>Cucumber<br>Pumpkin<br>Squash<br>Watermelon | Can follow earlier treatment for full season control. |

*Dacthal should be applied to clean, freshly worked soil. It will not control established weeds. Irrigation or cultivation should follow to move the chemical into the soil.*

dry will be needed. Avoid close, deep cultivation, for it will result in root pruning and consequent plant injury. The vine crops, being vigorous growers, will smother out late weeds if the row is kept clean until runners begin to cover the soil. Hoeing and hand weeding will usually do this best.

*Keep weeds from producing seed.* Allowing several flushes of weeds to emerge, then destroying them by thorough tillage, will help to reduce the weed problem in the future. But since many weed seeds have built-in survival mechanisms which prevent them from all germinating at the same time, several years of clean tillage may be required to reduce severe weed infestations.

## Mulches

Various mulching materials can effectively control weeds in the vine crops while providing other advantages at the same time. As soon as the seedlings are about 3 inches tall, straw, paper, peat or similar materials can be worked in around the plants.* This should suffice until the vines cover the ground and prevent further weed growth by shading.

Black polyethylene plastic film may be laid down after the soil has been prepared for planting. The edges of the plastic strips are buried 3 to 4 inches deep to hold the film in place. Slits can be made at proper intervals and seed or potted plants inserted through them.

When seeded cucurbits germinate they need to be gently pulled through the slit a few times. After that there is no problem. Plastic film will increase yields and earliness through conservation of moisture and nutrients and warming of the soil. Weeds that germinate beneath black plastic soon perish from lack of light.

Clear plastic can be used successfully as a mulch only when chemicals are first applied to control the weeds.

## Chemicals

For large plantings of cucurbits, chemical weed control methods should be considered. Certain herbicides can be very useful in reducing cultivation and hand labor, but proper use of the chemical is essential for good results. Inaccurate or otherwise careless applications are likely to injure the crop or give poor weed control.

The table opposite can be used by the home gardener as a guide for chemical weed control in vine crops. The chemicals should be applied in sufficient water to allow uniform coverage of a measured area. With practice, a volume of one gallon can be spread quite evenly over 100 square feet. When properly applied the chemicals listed will control many annual weeds and grasses. Use chemicals safely and wisely. *Read the label.* ♦

## Government Bulletin

Power sprayers of all kinds, as well as dusters, are described in detail and illustrated in a new 18-page Farmer's Bulletin (No. 2223) issued by the U. S. Department of Agriculture. It is obtainable for 15 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The purchaser's zipcode is requested.

For information on the use of sprayers and dusters for any specific purpose, the U.S.D.A.'s Office of Information, Washington, D. C. 20250, is prepared to aid any grower who sends in an inquiry. ♦

*See the Brooklyn Botanic Garden's Handbook on Mulches for other suggestions and for complete directions.—Ed.

*Cultural practices and herbicides both needed for*

# STRAWBERRIES

Richard D. Ilnicki

PULLING out weeds from the strawberry bed is a chore seldom relished by home gardeners, but the strawberry plants respond with more and finer fruit when they have the ground to themselves. Commercial growers meet the problem by using herbicides. Home growers who follow their example show wisdom.

Which herbicide to select is, however, a problem in itself. While it needs to have the power to eliminate weeds, it should not injure newly set out plants or the runners they develop, it should not inhibit the rooting of these runners, and it should leave no residue contaminating the ripening fruit. Furthermore, it should be safe for the home gardener to handle.

Fortunately, there are several herbicides that meet these requirements, and research men are steadily working to develop new ones. The most useful ones at present available for strawberries are **DCPA**, **diphenamid**, **sesone**, **2,4-D** and **DNBP**. These will eliminate much of the cultivation and hand weeding otherwise necessary to keep the rows of strawberries free of weeds. Some cultivation may be necessary, however, to remove existing weed growth before the herbicide is applied, to loosen the soil in order to enhance the activity of the herbicide, and to hasten the rooting of runners. Also, cultivation is often desirable to remove excess runner plants between rows in late summer.

Herbicides should be applied to established transplants, rather than to newly set ones, for the latter are usually under stress. It is generally best to wait two weeks before applying herbicides to the transplants. Here are directions for using the recommended herbicides.

## DCPA

DCPA (sold commercially as Dacthal) is not toxic to human beings or animals or to strawberry plants. It is not caustic or corrosive. After spray applications, the spray equipment needs only to be rinsed with clean water to remove contamination. Furthermore, there is neither a drift problem at time of spraying nor any volatility from the ground after spraying. Evidence from research also indicates that there is no carry-over in the soil.

DCPA must be applied before the weeds emerge and may be sprayed directly over the growing strawberry plants. It controls most annual grasses and broad-leaved weeds, except occasionally ragweed.

DCPA may be applied immediately after transplanting or to weed-free soil after an initial cultivation, usually 10 to 14 days after transplanting. Irrigating after application may help by incorporating the herbicide into the upper layers of soil. While repeat applications may be made throughout the summer, control will usually last for the greater part of the growing season. The soil should not be disturbed unless necessary. It is often better to hoe out the few surviving weeds than to cultivate or re-treat.

DCPA may be used in an established strawberry planting provided the bed is thin enough to permit the herbicide to reach the soil surface. It may also be applied after the removal of mulch in the spring before the weeds emerge.

> For 1,000 square feet: Add 125 grams of DCPA, the 75% active wettable powder, to 1 gallon of water.

It is wise to start mixing the material in a separate container, using just enough water to thoroughly wet the product. Then add this slurry to the rest of the water in the spray tank. Good agitation is necessary to keep any wettable powder in suspension. If screens or strainers are used in the sprayer, usually a 50 mesh or coarser screen is best.

## Diphenamid

Diphenamid is marketed under two commercial names: Enide, which is a 50% wettable powder, and Dymid, an 80% wettable powder. Diphenamid may be safely used on strawberries only during the season or year of establishment; it must not be applied in a year of harvest.

This herbicide should be applied to weed-free soil some two to four weeks after transplanting. Earlier applications often result in injury.

Federal restrictions imposed upon this herbicide do not permit its use at any time during a year prior to harvest, and it is very important to follow these directions. Full-season control of all annual weeds may be achieved with diphenamid. Some lamb's-quarters may survive this treatment, but these can be easily removed by pulling or hoeing. The spray can be applied directly over the plants.

> For 1,000 square feet: Use 50 grams of the 80% diphenamid wettable powder or 80 grams of the 50% material in a gallon of water.

## Sesone

Many home gardeners have been successful with sesone. This herbicide is an analog of 2,4-D and is available as a 90% active ingredient, soluble powder. The safe use characteristics of sesone are similar to those of DCPA.

Apply sesone to a weed-free bed 10 to 14 days after transplanting, but not during the rooting period of the runners. Rainfall or irrigation totaling ½ inch should occur or be applied a few days after an application to activate the herbicide for good weed control. Repeats on freshly cleaned soil are often necessary.

> For 1,000 square feet: Mix approximately 30 grams of sesone to 1 gallon of water. Mix the chemical with water in a separate container before adding to water in the sprayer to ensure complete solubility of the material.

Recently, it has been found by weed research personnel that combinations of sesone with DCPA or sesone with diphenamid, applied together in a spray tank mix, broaden the spectrum of weeds that can be controlled in strawberry plantings. It is suggested to use the recommended rates of each herbicide in the combination.

## 2,4-D

If 2,4-D is selected, the amine formulation of this herbicide is suggested. It is an aqueous solution containing 4 pounds of the acid equivalent per gallon. Its safe use characteristics are quite similar to those of DCPA or sesone, except that contamination of spray equipment is difficult to remove and drift at time of spraying should especially be avoided. Most annual and broad-leaved weeds except for chickweed and henbit are controlled with 2,4-D. Grasses are not affected. Weeds should be up and growing at time of spray application.

> For 1,000 square feet: Apply 6 to 10 cc. of 2,4-D per gallon of water.
>
> This treatment is for weed-infested fields that are to be carried over to the second picking year. It should be applied after harvest, but before the end of August.

## DNBP

If good weed control practices have been carried on throughout the year and a mulch has been put on in late fall or early winter, home gardeners will have little need for DNBP.

This is an aqueous solution containing 3 pounds of active ingredient of DNBP per gallon. It is poisonous, somewhat corrosive and stains yellow. Drift and volatility may injure ornamental plantings. However, there is no contamination in the sprayer and no residue in the soil.

If it is needed, it is strongly recommended that DNBP be used on a sunny day with seasonably high temperatures in late fall after strawberry plants have become dormant. This herbicide is a contact-type that is very effective on small chickweed and henbit plants, and is also good for winter annual weed control.

> For *one acre*: Apply 1½ to 2 quarts of the commercial product or 1½ pounds of active ingredient in some 20 or more gallons of water.
>
> For *1,000 square feet:* Use 3 tablespoons in 2 quarts of water.

(*Concluded on page* 43)

*Herbicides play important part in successful culture of*

# BLUEBERRIES

John A. Meade

IF the average home owner knew of the trials and tribulations that beset the commercial blueberry grower, he would not attempt to grow these fruits. Many, however, blissfully unaware of the many pitfalls, plunge ahead and amazingly enough manage to grow good blueberries.

To this band of hardy horticulturists this article is blithely directed. The following suggestions for weed control are for highbush blueberries alone; they do not necessarily fit a lowbush planting.

## Cultural Methods

First and foremost comes the time-honored method of controlling weeds—pulling or hoeing or cultivation by hand. Only one precaution here: do not cultivate too deeply or too close to the plants. The feeder roots on blueberries are very near the surface and you may cut off a good many with too vigorous a cultivation.

## Chemical Treatments

Commercial blueberries grow under rather peculiar conditions and hence have peculiar weed problems. Blueberries require a soil high in sand but also high in organic matter. The soil must be acid, pH 4.0 to 5.0, and have a high water table. These, of course, are the soils in which wild azaleas and mountain laurel as well as wild blueberries thrive. The recommendations below are developed for this type of soil. For soils other than these, consult your local agricultural authorities.

If you are tired of pulling crabgrass, pigweed, lamb's-quarters and other weeds out of your blueberry plantation, here is what to use:

1. ***Diuron***——sold as Karmex DW, an 80 per cent wettable powder.

   Put 26 grams or 1 ounce in 1 gallon of water, shake well, and spray on 1,000 square feet of soil. Avoid applying the spray to the blueberry foliage.

2. ***Simazine***——sold as Simazine 80W, an 80 per cent wettable powder.

   Put 52 grams or 2 ounces in 1 gallon of water, shake well, and spray on 1,000 square feet of soil. Avoid applying the spray to the blueberry foliage.

   Simazine is also sold as a 4 per cent or 8 per cent granular material. Apply 1,040 grams or 2¼ pounds of the 4 per cent or 520 grams or 1¼ pounds of the 8 per cent to 1,000 square feet of loose soil.

Both of the above should be applied to weed-free soil in early spring prior to bloom (April in New Jersey area). These herbicides will prevent new weed seeds from germinating but will not kill weeds already up. *Use these herbicides only on bushes which have been in place more than one year.*

3. ***CIPC or Chloro IPC***——sold as an emulsifiable concentrated liquid, also as a 5 per cent or 10 per cent granular form.

   Put 87 milliliters (3 fluid ounces or 6 tablespoonsful) of the emulsifiable liquid in 1 gallon of water and spray on 1,000 square feet of soil.

   Apply 830 grams or 1¾ pounds of the 5 per cent or 415 grams or 14½ ounces of the 10 per cent granular form to 1,000 square feet of loose soil.

This herbicide applied to weed-free soil in the fall will prevent germination of most winter annual species. It can also be applied in the spring to control such annual grasses as crabgrass, barnyard grass

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Information for this article obtained from William V. Welker, Horticulturist, Agricultural Research Service, U. S. Department of Agriculture, and Rutgers—The State University, New Jersey.

Sheep-sorrel *(Rumex acetosella)*, above, and chickweed *(Stellaria media)*, at right, are common weeds among blueberries and in most other cultivated crops. Chloro IPC controls chickweed. Sheep-sorrel is best pulled by hand.

*Roche photos*

and goosegrass. It is also effective against chickweed and dodder.

All of these applications should be followed by ½ inch of irrigation to carry the herbicide into the soil where the weed seeds are germinating.

Do not cultivate the blueberries unless for some reason the herbicide fails and weeds come in.

The herbicides mentioned here are available from most farm or garden supply stores. Other materials are constantly being evaluated for effectiveness in blueberries but these, so far, have proved safest and most efficient.

One final word of caution: Do not add "one more for the pot" with weedkillers. If applied at too high a rate, blueberry injury can occur. Use the recommended amount and *read the label.* ♦

## STRAWBERRIES

(*Continued from page* 41)

### Additional Herbicides

There are still other commercial herbicides available that have approval from Federal authorities to be used in strawberry culture. They will not be discussed here because the care necessary for their safe use is beyond that which can be given by the home gardener.

The herbicides discussed above, when properly applied, can effect more than adequate weed control for the home gardener as well as the commercial grower.

Remember, *always read the directions on the label* and follow them. ♦

### Protection from Herbicide Damage

Activated carbon* will protect strawberry plants from damage by several commonly used herbicides. Roots are dipped in the powdered charcoal substance before they are set in the ground. One pound is sufficient for dipping 300 to 500 plants. Normal production of runners has ensued in separate plots that have been treated with sesone, diphenamid, simazine and DCPA. Experiments were carried out by Dr. John F. Ahrens of the Connecticut Agricultural Experiment Station at its Valley Laboratory in Windsor.—Ed. ♦

*Available at drugstores for about $3 a pound, or in larger quantities in 35-pound bags for less than $5. A product of the West Virginia Pulp and Paper Company, 230 Park Avenue, New York, N. Y. 10017, it is distributed by the Chemical Corporation, 54 Waltham Avenue, Springfield, Massachusetts.—Ed.

*Herbicides aid in thinning plants and killing weeds in*

# BRAMBLE FRUITS

William E. Chappell

THE brambles, which are members of the genus *Rubus*, a large group of thorny shrubs in the rose family, include raspberries, blackberries, boysenberries and others grown for luscious fruits too seldom found fresh in the markets. The way brambles grow is often both the delight and the despair of gardeners; the roots produce new sprouts several feet from the original stem. The result is that plantings tend to spread out and become impenetrable, or they become choked with grasses and other weeds protected by the guardian bramble thorns.

Frequent pruning and mowing between rows are the easiest ways to keep small berry patches small. Where mowing is impossible, treatment with chemicals is the sensible way to remove unwanted sprouts and prevent weed invasion. Chemicals alone, however, cannot insure good growth and weed-free conditions. To achieve these, proper pruning, fertilization, and pest control must also be carried out.

## Thinning Brambles with Dinitro

When plantings become too vigorous and thick, sprouts can be killed with a spray containing dinitro, a material which kills on contact but does not move to unsprayed parts of the plant. The spray must be applied carefully to avoid its getting on sprouts that are to be saved. It has only a short life in the soil. Treatment should be repeated as needed to keep new sprouts from developing.

## Weed Control in Old Plantings

Since bramble plants are susceptible to injury by herbicides, most of the chemical treatments recommended are preventive. That is, they are applied to clean-cultivated soil to keep it weed-free. The materials suggested below do not kill established weeds; these must be pulled or removed mechanically. After this has been done, and the soil cultivated, simazine will prevent the germination of annual broadleaf weeds and grasses for a season. It is available as a spray or as a 40 per cent granular material. Simazine should be used only once a year, either in spring or fall, and must be kept off desirable lawn grasses.

> Spread granular simazine evenly at the rate specified on the label, usually about 1 to 2 pounds per 1,000 square feet. This is easier to apply than the liquid.
>
> For liquid treatment, use 1 to 2 ounces of Simazine 80W per gallon of water to cover about 1,000 square feet of area. If applied with reasonable care, this spray will not hurt the canes.

## New Plantings

Before setting out newly rooted cuttings of raspberries or related fruits, it is essential to have the soil in good condition. It should be worked up and fertilized, and all roots and other weed debris should be removed. In stony areas and on rock ledges, individual holes should be dug and the soil loosened before planting.

> For pre-emergence weed control apply 1 ounce of Simazine 80W in 1 gallon of water per 1,000 square feet directly over the newly planted canes.

If weeds come up later in the season, use the dinitro treatment outlined above. Be sure to keep the dinitro spray off the young canes.

## Special Problems

***Quackgrass.*** Where quackgrass is a problem, apply simazine in the fall for best results. In most areas this should be done in October or before hard freezes

occur. In the milder climates it can be as late as December 1. The main thing is to spray while the quackgrass leaves are still green.

Use 2 ounces of Simazine 80W per gallon of water and wet the quackgrass thoroughly.

*Bermuda grass.* There is no suitable chemical for removing Bermuda grass from established plantings. This grass must be treated *before* infested areas are planted.

Use 1 pound of dalapon in 5 gallons of water and spray during the summer months. Repeat the spray if any new growth appears. ♦

## KILLING BRAMBLES

Sometimes, instead of growing brambles, it is desirable to kill them. Perhaps the area they occupy is to be used another way, or coarse, unproductive plants are to be eliminated. If so, advantage can be taken of the fact that they are sensitive to 2,4,5-T. Use a brushkiller or other herbicide containing 2,4,5-T for spraying the plants to be killed, wetting all leaves, stems and suckers thoroughly to the ground line.

This treatment for eliminating brambles may be made any time late in the season after foliage matures until plants begin to go dormant.

# WHY AND HOW TO CALIBRATE EQUIPMENT

WHY is calibration so important when using weedkillers? Because recommended rates are based on applying a given amount of *chemical* (not solution) to a specified area. This is the opposite of insecticides or fungicides, which are made up to a certain concentration for application at will.

With weedkillers, the amount of water or other carrier can vary widely without making a significant difference, but the amount of concentrate (the packaged product) must remain the same for the given area. In other words, the nozzle orifice, pressure, speed of application and other factors may determine discharging one or 40 quarts of water over a 100-square-foot area. *The amount of product* to be added to the water *remains the same* in either case.

Careful measuring and uniform application are essential, too. This is because most herbicides are growth regulators, and are active in very small amounts, usually from 1 to 8 pounds per acre, rather than 1,000 to 2,000 pounds per acre as with fertilizers. If even a small error is made, it will be proportionately large and change the effect of the chemical.

It is a good idea to test your sprayer with plain water on a 10 x 10-foot area (100 square feet). This way you can find out how much your sprayer applies at a comfortable speed. Then you can figure how much and how strong a solution to make up for treating your lawn or other planting with your sprayer. Once the general rate of application has been established by calibrating, it can be used as a gauge for that particular piece of equipment, and the procedure need not be repeated unless one or more factors may be changed.

Plan to apply the solution by criss-crossing, spraying first from end to end and then from side to side. This will assure even application.

# PICTURE DICTIONARY OF COMMON WEEDS

Tall fescue
*(Festuca elatior arundinacea)*

Hairy Crabgrass
*(Digitaria sanguinalis)*

Smooth crabgrass
*(Digitaria ischaemum)*

Bermuda grass or wire grass
*(Cynodon dactylon)*

Nimblewill
*(Muhlenbergia schreberi)*

Creeping bentgrass
*(Agrostis palustris)*

Goosegrass
*(Eleusine indica)*

Quackgrass
*(Agropyron repens)*

Pigweed
(*Amaranthus retroflexus*)

Mugwort
(*Artemisia vulgaris*)

Lamb's-quarters
(*Chenopodium album*)

Lawn pennywort
(*Hydrocotyle sibthorpioides*)

Ground-ivy or gill-over-the-ground
(*Glechoma hederacea*)

Sheep-sorrel
(*Rumex acetosella*)

Dandelion
(*Taraxacum officinale*)

# NATURAL LANDSCAPING WITH HERBICIDES

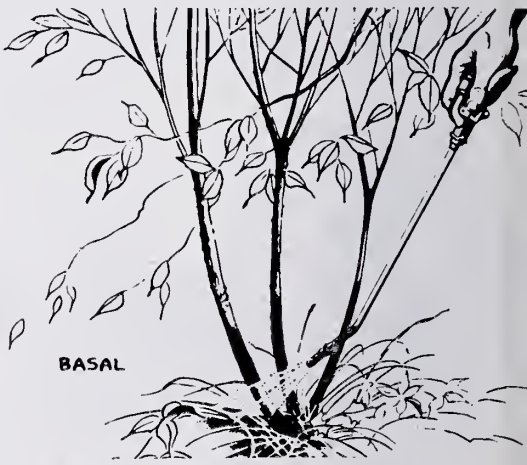
*The most attractive wild plants can be encouraged by selective spraying of less desirable kinds with chemicals harmless to wildlife*

**William A. Niering and Richard H. Goodwin**

WILD or unused land in various stages of natural revegetation may possess great charm or may have tremendous aesthetic potential, if skillfully manipulated and maintained. Attractive native species of plants are usually growing spontaneously in such areas and only need encouragement through selective removal of the less desirable species that are crowding them. Here herbicides provide the owner with a technique for enhancing and maintaining the beauty of his property with a minimum of effort and expense.

In order to get the most out of a natural tract of land one should first take an inventory of the native species that are already present, their location, condition and potential size. Some may already be fine specimens and well placed, some may only be seedlings, and still others may be malformed or diseased. With this information in mind, plan the type of effect you wish to achieve—an open meadow dotted with specimen trees and shrubs, a screen from the highway or neighbor's yard, a shrub border at the edge of a woodland, swamp or pond. There are as many possibilities as there are tracts to be landscaped. Often enough attractive and interesting species will already be present, but if not, more can be planted. Native species are ideally suited to the climate and require minimum care.

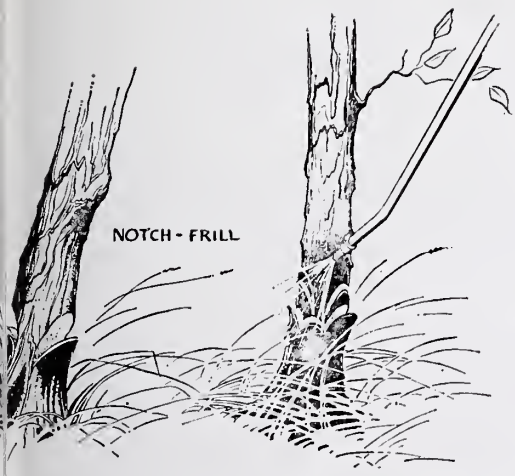
Wherever weedy or otherwise undesirable trees, shrubs or vines are present, these plants may be selectively eliminated by appropriate treatments, *e.g.*, trees can be cut down, and the stumps treated with an herbicide to prevent resprouting (*stump treatment*). Or, if desired, trees can be notched or frilled at the base with an axe and the notches or frills treated (*notch/frill treatment*). In this case the tree will die standing and can be removed later or allowed to rot and fall, depending upon the circumstances. Shrubs, too, can be cut and stump-treated or the herbicide applied directly to the bases of the stems (*basal treatment*). Vines, briers




Basal treatment, one of three practical methods for eliminating unwanted woody plants through use of herbicides. The lowermost twelve inches of the stems of shrubs (or the trunks of small trees) are sprayed until the herbicide soaks down around the root collar at the ground line. One part of the herbicide (2,4-D and 2,4,5-T together, commercially available as "brushkiller" everywhere) is combined with 20 parts of kerosene or other fuel oil for effective kill of most woody species.

Condensed from "Creating New Landscapes with Herbicides: A Homeowner's Guide." Bulletin No. 14, The Connecticut Arboretum. Available for $1 from the Arboretum at Connecticut College, New London, Connecticut. Discount given on quantities sent to one address.

Reprinted from PLANTS & GARDENS, Winter 1963-1964.




In the notch and frill treatments, tree trunks are notched with an axe (as at left) or frilled with shallower cuts (right), and the exposed wood is soaked with the kerosene-diluted herbicide. As an alternative, Ammate crystals may be placed dry in the cuts.

To keep a recently felled tree from resprouting, the stump may be treated with the herbicide. Soak bark until the liquid runs down to the root collar. Or, place Ammate crystals directly on the stump's cut surface.

and brambles may also be selectively eliminated with the use of chemicals. Details concerning the types of herbicides and methods of application are discussed in detail in this bulletin.

Whenever it is practical, pulling young plants or seedlings by hand is to be preferred to the chemical approach. Nonsprouting species, such as the majority of the conifers, will obviously not require a chemical application.

If care is exercised, it is possible to eliminate the undesired species with almost no damage to adjacent vegetation. Thus, crowded specimens may be released, vistas opened up, and handsome plants made focal points or given the optimal surroundings for effective display.

The natural vegetation can also be manipulated by weed-killers in order to create or maintain various types of wildlife habitat. Different environments, such as dry fields, wet meadows, semi-open fields and thickets, support distinctive types of wildlife.

A grassland can be maintained by occasional mowing, by selectively spraying the woody species with herbicides as they appear, or by a combination of these methods. To maintain a thicket, trees, which would eventually shade out the shrubs, must be removed by basal, notch/frill, or stump techniques (see illustrations).

In the small woodlot or forest plantation, chemicals are useful in eliminating undesired competitive species. They can be used to good advantage in thinning an over-stocked stand where stem density is too great to permit successful development of individual trees. In Christmas-tree or other plantations, competing hardwoods can be readily removed with herbicides. The techniques to be used are essentially those illustrated here.

At the Connecticut Arboretum, two areas have been successfully landscaped with herbicides. The principal chemicals used have been the phenoxy compounds, including 2,4-D and 2,4,5-T, Ammate and aminotriazole. They are all subject to breakdown by microbial action and hence probably have no cumulative residual effect on the soil or food chain. Arsenical compounds and soil sterilants are not recommended.

# WILDLIFE RESPONSE TO CHEMICAL BRUSH CONTROL

Wildlife, although only occasionally observed by the general populace, is an important element of the landscape along highways, under power lines, and on other public lands which merge with areas where wild creatures make their homes. Hunters and hikers get closer to the animal inhabitants of the land than do the casual motorists.

Rural residents whose property may include large uncultivated areas are likely to be concerned with the development of favorable conditions for wildlife survival and increase. They, as well as persons whose work relates to public lands, can obtain practical guidance from the results of 13 years of tests made in Pennsylvania. That is probably the longest-term series of continued observations on chemical brush control on rights-of-way that has ever been made for the primary purpose of observing the effect on game food and cover.

The change brought about in the vegetation has resulted not only in the types of plant cover needed on a right-of-way, but also in greatly increased use of the treated area by desirable wildlife. The various treatments and a summary of their effects are described below by the man who planned and directed the work.

W. C. Bramble

WITH the public interest in mind, a series of tests of commercial sprays for brush control was begun in 1953 on a section of power-line right-of-way in central Pennsylvania and continued through 1966. Test plots on a 180-foot-wide right-of-way varied from approximately two to four acres. The woody shrub layer to be controlled consisted primarily of clumps of tree sprouts 3 to 6 feet high. Species included several oaks, red maples, sassafras, aspen, cherries, hawthorn, and others.

Each of six types of treatment was repeated four times to minimize differences due to the location itself. The treatments were:

A. Left unsprayed for comparison
B. Broadcast foliage spray of 2,4-D plus 2,4,5-T
C. Oil-water, semi-basal spray of 2,4-D plus 2,4,5-T
D. General summer basal spray of 2,4-D plus 2,4,5-T
E. Selective winter basal spray of 2,4,5-T
F. Broadcast foliage spray of Ammate.

All of the plots were sprayed in June 1953 except E, which was treated the following January. In June 1954 a follow-up basal spray was applied to one half of each treatment. Observations were made periodically for 13 years after the initial chemical application, and the woody plants that emerged from the herb-grass ground layer to become brush were tallied.

Two growing seasons after the initial spraying (that is, at the end of 1954), woody plants on all sprayed areas were practically nonexistent except for a few scattered sprout clumps which had been

missed or not thoroughly sprayed. Such an effective treatment can readily be attained by applying adequate volumes of spray with care and in proper concentrations.

Comparisons made in 1965 revealed that the semi-basal spray has been superior to all other chemical treatments in preventing redevelopment of a woody shrub layer. There were only 60 plants per acre on the average following this treatment. Other treatments produced results that varied from 110 plants per acre for the broadcast 2,4-D + 2,4,5-T to 1,136 plants for the winter basal. Development of numerous root suckers by sassafras accounts for the higher figure.

The efficiency of combining the initial chemical treatment with a quick follow-up was evident in 1965. The layer of undesirable woody plants which was nearly eliminated by the initial spray treatments continued to have fewer than 100 woody plants per acre in 1965 on all but one treatment. The latter (combination of two summer basal sprays) had an average of 286 plants per acre in 1965. Therefore, it can be said that the control obtained by all treatments immediately following spraying and for the next 13 years after a follow-up basal spray was used proved to be exceptionally good.

It appears probable that it will require very little effort or expenditure to maintain the right-of-way in a brush-free condition for many years in the future. Probably maintenance treatments over the coming years will consist of very light basal spray applications that will not greatly disturb the plant cover or appearance of the right-of-way.

## Development of a Shrub Edge

A unique feature of the selective winter basal treatment technique was the intentional development of a woody shrub layer along the edge of the right-of-way. This was accomplished in the initial and follow-up sprays by avoiding application to low-growing shrub species such as bear oak *(Quercus ilicifolia)* and witch-hazel *(Hamamelis virginiana)* on a 33-foot strip along each side of the right-of-way. All woody brush in the center of the right-of-way was sprayed. Such treatment aims at a right-of-way with a low ground layer of grasses, herbs, and small shrubs under 3 feet in the center and a taller shrub layer along the edge, bounded by the tree layer of the adjacent forest.

After 13 years of growth, there was an average of 248 bear oak and witch-hazel plants per acre, ranging from 3 to 8 feet in height, distributed along the 33-foot edge. In addition, mountain-laurel *(Kalmia latifolia)*, with its showy flowers and glossy evergreen leaves, was prominent in many sections. The shrubby edge helps provide needed food and cover for wildlife.

## Developing a Stable Ground Cover

If the components of the ground cover in the area where woody plants were being sprayed could be kept in a stable condition, and also become dense enough to resist invasion by tree seedlings, a major objective would be achieved. Such conditions would tend to prolong the effect of the initial chemical brush-control and reduce the need for repeated sprays. This has been accomplished. The original ground cover, which has been designated as a bracken-sedge-herb-blueberry plant community, after its dominant species, has been successfully maintained and thickened where selective basal sprays were applied.

The plant composition in the areas of both the summer and winter basal sprays remained essentially stable from 1953 through 1965. The greatest change has been an increase in blueberry.

The oil-water, semi-basal spray caused a marked decrease in blueberry but maintained bracken and sedge. In five years, the original plant composition had been regained.

Although the areas given broadcast foliage sprays suffered marked changes in plant composition, they too returned to much the same original ground cover in about five years. Sweet-fern (*Comptonia peregrina*), however, replaced blueberry as the dominant low shrub.

Density of the ground cover was also maintained by the selective basal sprays. The disturbance was much greater, as

## How to Treat Unwanted Woody Plants

**Foliage sprays** of brushkillers diluted with water are commonly used on small trees or thick stands of mixed species. They can be applied from the time foliage is fully developed until plants begin to go dormant. For kill, all leaves, stems and suckers must by thoroughly wet to the ground line. Some regrowth may be expected on resistant species such as ash, oak and persimmon.

**Basal sprays** can be applied in any season. The usual procedure is to mix the brushkiller with kerosene or furnace oil and thoroughly wet the basal 10 to 15 inches of every stem or trunk (all around) until the spray collects around the root collar at the ground line. Basal sprays are used on scattered brush, or as a second spray on species resistant to a first foliage spray. They minimize danger to desirable plants nearby.

**Semi-basal sprays** are also used selectively, primarily by commercial applicators. The diluent is a combination of oil and water, and the technique involves thorough application to the lower two-thirds of the plant.

**Stump treatment** with brushkiller diluted with oil prevents resprouting and can be used at any time of year. It is most effective when applied as soon as possible after trees (3 to 4 inches in diameter or larger) have been cut. Spray the entire stump, particularly bark and exposed roots. Thorough drenching is essential for kill.

**Frill treatment** involves using an axe to cut overlapping notches in a continuous ring around the trunk line near its base. Cut through the bark but do not remove chips. Pour in as much of the brushkiller mixed with oil as the frill will hold. This method is recommended for cull trees 5 to 6 inches or larger in diameter.

*Follow manufacturer's directions for specific plants, for concentrations of herbicides to be used, and for exact methods of application.*

might be expected, with oil-water and broadcast sprays.

All sprayed areas recovered quickly, and by the second year the ground cover occupied 70 per cent or more of the area. Five years after spraying it was practically complete except for stumps and stony areas.

While tree seedlings remained numerous in the ground layer, the resurge of brush was very sparse in all cases where a summer basal had followed the original sprays, indicating that new invasion had been held to a low point. Perhaps the best evidence of resistance to resurge by woody brush was the minimum treatment needed in 1966, 14 years after spraying.

### Game Usage

Certain important trends appear in the number of times wildlife species, or signs of them, were observed on treated areas during the five years following spraying. For example, deer were not only observed on all treatment areas but the total usage of these areas increased. The control area, the section where no spraying was done, was used heavily in winter for bedding down and for feeding on woody browse. The adjacent woods, which are seriously over-browsed, were nearly bare of low cover and food. In the treatment areas, deer fed heavily in spring and early summer on young shoots of bracken and on the common wild loosestrife (*Lysimachia quadrifolia*). Also, deer commonly bedded down in treatment areas where grass and sedge were common.

Grouse were observed in all treat-

## WEED-CONTROL ARITHMETIC

### Conversion factors for the use of herbicides

t = level teaspoon
T = level tablespoon
(standard kitchen measuring spoon)

| | |
|---|---|
| 3 t = 1 T | 2 cups = 1 pint |
| 2 T = 1 fluid ounce | 2 pints = 1 quart |
| 16 T = 1 cup or 8 fluid ounces | 4 quarts = 1 gallon |

1 gallon water = 8.34 lbs.
1 gallon = 3785 ml. (milliliters)
2 lb. per 100 gal. = 0.32 oz. per gal.

**Area Applications**

1 acre (A) = 43,560 sq. ft.
1 ounce = 28.34 grams
1 ounce = 29.57 ml.
1 pound per acre = 0.0104 grams per sq. ft.

Example: A granular material is recommended at 100 lb. per acre. How much does one use on 100 sq. ft.?

Calculation: 1 lb. per A = 0.0104 grams per sq. ft. = 1.04 grams per 100 sq. ft.
100 lbs. per A = 104.0 grams per 100 sq. ft.

$$\frac{104.0}{28.34} = 3.66 \text{ oz. (little less than } \tfrac{1}{4} \text{ lb.)}$$

Example: A liquid is recommended at 100 gallons per acre. How much does one use on 100 sq. ft.?

Calculation: 1 gal. per A = 0.08689 ml. per sq. ft. = 8.689 ml. per 100 sq. ft.
100 gal. per A = 868.9 ml. per 100 sq. ft.

$$\frac{868.9}{29.57} = 29.38 \text{ oz. (little less than 1 qt.)}$$

From *Pesticide Handbook*, Miscellaneous Publication No. 8, Virginia Cooperative Extension Service, 1965.

ed areas; and in addition, they were often found on the edges within 150 to 200 feet of the right-of-way. Young turkeys used openings in the summer when feeding on various insects. Use of the right-of-way by squirrels was mostly along the edges where oaks and other mast-producing trees and shrubs furnished food. Rabbits increased on the treatment areas over the observation period. The abundant low cover and food on the right-of-way, as opposed to the woods, was apparently attractive to them. Even a black bear and her cubs were found sleeping in the protection of the dense bracken cover on the right-of-way!

In June of 1965, there was a striking use of bracken fern and of some of the common herbs, including loosestrife and goldenrod (*Solidago* species). Also heavily used were the shrubs blackberry, (*Rubus* species) witch-hazel, (*Hamamelis*) and sweet-fern (*Comptonia peregrina*). As bracken was most abundant and most heavily eaten, it became of special interest. By sample clipping and later drying and weighing, it was estimated that there were about 424 pounds of bracken (air-dry weight) per acre on the right-of-way. It was generally green with numerous fresh sprouts even in late June as compared to the sparse, wiry-stemmed bracken in the adjacent forest. The food value of the bracken based on a standard feed analysis was fairly high. The younger stages, which seem to be preferred by deer, were particularly rich in nutriment as compared with the mature state and with other forage plants. ♦

Spotted or prostrate spurge
(*Euphorbia supina*)

Wild garlic
(*Allium vineale*)

Dichondra
(*Dichondra repens*)

Dodder
(*Cuscuta gronovi*)
growing on a clover

Heal-all or self-heal
(*Prunella vulgaris*)

Sticktight or creeping beggarweed
(*Desmodium canum*)

Sandspur or field sandbur
(*Cenchrus longispinus*)

Henbit or dead-nettle
*(Lamium amplexicaule)*

Mouse-ear chickweed
*(Cerastium vulgatum)*

Thyme-leaved speedwell
*(Veronica serpyllifolia)*

Common chickweed
*(Stellaria media)*

Buckhorn or narrow-leaved plantain
*(Plantago lanceolata)*

Common plantain
*(Plantago major)*

# JAPANESE-BAMBOO

## *Two Polygonum species are variously classed as garden plants, wild flowers or weeds*

**A. M. S. Pridham**

WHETHER the plant known as Japanese-bamboo is friend or foe is a question the gardener who has it must decide for himself. It is not a bamboo, nor even remotely related to the bamboos (which are woody grasses) but is one or another species of *Polygonum*—in other words a knotweed—either *P. cuspidatum* from Japan or the larger, coarser, more scantily flowered *P. sachalinense* from the island of Sachalin north of Japan and Korea.

These two species were introduced into the United States in the late 19th century, the Japanese species as an ornamental, largely for its lacy whitish flowers in September, the other in part for forage. They also have been planted for erosion control along road cuts, both railway and highway, as well as on private property. Individual plants or clumps left alone without care expand slowly and can be useful as landscape plants. Both kinds have large, somewhat heart-shaped leaves ranged along hollow, arching, reddish stems which grow very rapidly to a height of 5 or 6 feet.

Because the annual stalks of both these species are killed by the first light frost, farmers are more likely to look upon the plants as frost indicators rather than as ornamentals. At this stage they are no longer decorative, and gardeners often object to having to tidy up the brown foliage that is not shed until late fall and the long dead stalks that would remain standing over winter.

The ability to grow and persist in rough places where little else can thrive means that in better ground these large polygonums overwhelm all other vegetation. For years, most attempts to eradicate them have been futile.

Digging the plants can be quite a chore since the underground stems grow to 5 feet or more. Hoeing or cutting them is a fine way to encourage new and more profuse growth. A two- to four-year program of removing all young shoots is a surer way of getting the situation in hand.

But what can be done to be entirely rid of Japanese-bamboo without waiting several years? Such procedures as laying asphalt over several layers of polyethylene film on a leveled surface is one possibility. Other similar construction projects, such as a patio or parking area, also offer solutions. Even a double layer of black polyethylene alone, held in place by boards or stones, is an answer to the problem. If topped by potted plants set on gravel, it is a good horticultural modification.

Many weedkillers sprayed on polygonum foliage will kill or partly kill the leaves and stems, depending on the time of year; so, too, will frost. When used on the soil surface in fall, some weedkillers will enter the underground parts of the plants and kill them back with varying degrees of completeness. Fall rains, winter snow and spring moisture are helpful in carrying these chemicals to the root zone. They might also carry certain of them to the underground parts of other plants, which could die as a result, and to underground sources of water, which could thereby become contaminated. Caution is particularly needed where the recent years of drought have led to the digging or drilling of new wells. Where Japanese-bamboo is adjacent to a well or to any situation involving ground water, either it should be tolerated or plastic or asphalt should be used to control or eliminate the plants.

When Japanese-bamboo is a serious

When in flower, Japanese-bamboo *(Polygonum cuspidatum)* is readily classified as an ornamental plant, but when it spreads beyond its allotted space, it becomes a stubborn weed. A granular herbicide in autumn is one recommendation for control.

*Roche*

problem and contamination hazards do *not* exist, then the following instructions and suggestions for control with a herbicide may be helpful.

## What to Do

Cut back tops from May through July to force many shoots to grow.

Select a herbicide in granular rather than spray form. Either dicamba or picloram is suggested.

> Use the granular herbicide at the rate of about ⅓ ounce of active herbicide per 1,000 square feet. Apply in late summer or fall, even after frost has killed garden flowers, or in spring (before May).

On a calm day, shake herbicide granules very lightly over the plants and adjacent ground where the chemical can be absorbed by the underground stems and roots. But avoid using a weedkiller such as dicamba or picloram where it could be absorbed by roots of valuable plants. Large amounts of activated charcoal worked into the soil among ornamental plants or in wet areas serve as a measure of protection from herbicide damage.

If you are experienced with spray equipment, spray base of stems and soil lightly but uniformly under a 12- to 18-inch canopy of regrowth foliage in August after a July cutting.*

Persist with spot treatment of new shoots for complete elimination of Japanese-bamboo.

## What Not to Do

Do not spray tall foliage during May, June or July while garden plants are growing rapidly.

Do not spray on a wet, foggy or windy day.

Do not use more weedkiller than is recommended.

Do not use herbicide near wells, streams, lakes or ponds in such a way that water seepage is contaminated by direct contact or by seepage of the chemical through the soil. ♦

**Note:* After spraying, wash out sprayer and its parts as directed on page 76, using special care to leave all parts of the sprayer clean. Bury empty herbicide containers in a plot free of garden plants. Otherwise, store the closed marked containers in a safe place, preferably under lock and key. Do not burn or re-use empty herbicide containers.

# CANADA THISTLE

## *A stubborn pest demanding perseverance for control*

E. P. Sylwester

CANADA thistles are no respecters of titles, fence lines, or property. Their windblown seeds can establish a beachhead almost anywhere. They occur in lawns, flower and vegetable gardens, ornamental plantings, in raspberry plantations, empty lots, under fruit and shade trees, under and among grapes, in parks, preserves, wildlife and natural areas, pastures, along roadsides, ditch banks and fencerows, in corn and soybean fields. Once they establish a foothold they are hard to eradicate. Their persistence to exist, their remarkable recuperative powers, make them one of the most feared of our noxious weeds. Left uncontrolled, they establish a heavy, thick patch, often driving out completely the desirable plants among which they are growing.

Prevention is infinitely better than cure. Eternal vigilance to eradicate the young plants and patches as soon as they are discovered will pay big dividends.

How can the average home owner wage a successful campaign against this weedy pest? A "bird's-eye view" of methods of control for different situations is given below. Additional information is always available from the local extension service and this should be obtained before a control program is started.

### In Lawns

Canada thistle is seldom a serious pest in lawns. Close mowing, done repeatedly, will deplete food reserves and gradually drive it out. Eradication in lawns can be implemented by spraying with 2,4-D.

> Use 1 tablespoon of the 4 pounds per gallon amine formulation of 2,4-D in 1 gallon of warm soft water. Add 1 teaspoon of any liquid household detergent to increase absorption, translocation and kill. Put on with a sprinkling can to avoid all danger of spray drift. Such contaminated equipment should not be used for other purposes. Repeat the operation if Canada thistles reappear.

Canada thistle (*Cirsium arvense*) spreads by means of numerous root suckers, also by countless seeds. Persistence is needed to eradicate it. Frequent hoeing and spot treatment with a herbicide are among the methods suggested.

### In Gardens

Routine hoeing will usually control Canada thistles. However, if they create a problem in a garden, put in *erect*-growing plants such as okra, peppers, eggplant, sweet corn or, if flowers, zinnias, cosmos,

cannas, etc. Such plants permit *repeated, regular* cultivations throughout the entire season. One or two years of such procedure usually drives out Canada thistles completely. Hoe whenever their green growth reappears.

Careful spot treatment with 2,4-D or amitrole will also help. Hoeing and treatment with chemicals can be alternated if desired. To avoid injury to nearby garden plants, nail a portion of a sponge or heavy rag to the bottom of a stick, soak it in the solution to be used and *carefully* swab the Canada thistle rosettes when they are 2 to 4 inches high.

If 2,4-D is the choice for swabbing, use only the 4 pounds per gallon amine form, 2 tablespoons of concentrate per pint of water.

If amitrole is selected, use 2 tablespoons of the liquid (Cytrol or Amitrol-T) or 2 ounces of a powder formulation (Amino Triazole or Weedazol) per pint of water. Repeat as new growth appears. In vegetable and flower gardens, amitrole is safer to use than 2,4-D.

## Around Fruits

Under grapes and fruit trees and in raspberry beds and other plantings of fruit crops, frequent hoeing will gradually drive out Canada thistles. If many susceptible plants are in the area, hoeing regularly whenever new growth appears is the safest method. Once thistles are controlled, heavy mulching or complete covering with black plastic will help prevent seedling reinfestation. If cautiously done, 2,4-D can also be applied as a swab, as mentioned previously, but under grapes (which are extremely sensitive to 2,4-D) it would be safer to use amitrole.

## Large Area Control

In fields, ditch banks, fence rows, roadsides, pastures, etc., where Canada thistles are a problem, the landowner who is equipped with good machinery and other implements has additional methods of control at his disposal. Local agricultural authorities, notably the State and County Extension Services, should be consulted before a program is started. Such advice will pay big dividends.

Among the practical methods are summer fallow for small areas; smother crops followed by fallow for remainder of season; spraying with 2,4-D; combination of grass family crops in conjunction with a spraying program with 2,4-D; spot treatment with amitrole; foliage spray or pellet treatment with Tordon (certain crops cannot be grown for two or three years); small spot treatment with granular Benzabor, Trysben or Benzac (keeping 50 feet away from desirable shrubs and trees); spraying corn crops with atrazine or using a 2,4-D blanket treatment.

Any method of control is only as effective as the operator makes it. These are some of the steps to success:

Adopt a "program of control" and stick with it until the thistles are eradicated.

Choose that method which best fits into your particular problem or operation.

Always secure additional information from your local Extension Service. This is necessary because crops and climatic conditions vary.

Always follow direction on chemical containers closely in order to comply with all safety directions, tolerances, usages, and clearances.

Remember that any method which prevents the thistle plants from manufacturing food (photosynthesis) will eventually eradicate this pest. The plants are not going to give up easily. That's what makes them noxious weeds. However, they are not "super-plants" that can withstand eradicative measures indefinitely. Resolve in your own mind first that you are going to out-persevere them. Only then will you achieve success in eradication. ♦

# NUTSEDGE—*A pest that is hard to eliminate*

**Barbara H. Emerson**

OBJECTIONABLE color and rapid growth in lawns, tubers that produce new plants by the thousand, rhizomes that can pierce and grow through potatoes . . . these features characterize the pest called nutsedge. The designation nut*sedge,* rather than nut*grass,* is significant for the plant is a true sedge. Once considered chiefly an inhabitant of wet places, nutsedge now frequents dry places too. The northern "yellow" species (*Cyperus esculentus*) also appears in the South, where its "purple" relative (*C. rotundus*) is more common.

When pulled by its crisp light-colored leaves, a nutsedge plant seems to come up easily, but has left behind its survival kits, the nutlike tubers responsible for its name. These have a tremendous reproductive potential.

Tubers are the chief means of nutsedge dissemination in cultivated land. They may remain viable in the soil for several years before conditions are right for germination. An abundance of viable seed is produced, too. If undisturbed, seedlings produce both seed and tubers the first season of growth.

The seedlings are easily destroyed by cultivation. Shading and the competition of rapidly growing crops reduce nutsedge foliage and tubers. It is important to prevent tuber production in late fall as well as during the early part of the season. Most tubers are produced in the upper 6 inches of soil. Two years of mechanical or chemical fallow are needed to get a 90 per cent reduction of the viable tubers in the soil. But since the remaining tubers are capable of reinfesting the area, nothing short of complete eradication can give permanent relief from the pest. This means continuous attack over a long period of time.

Nutsedge, with its many tubers, is one of the most pernicious of all weeds.

**Atrazine** applied when the nutsedge is just emerging will give good control if spraying is followed in two weeks by one or two cultivations. This is recommended as a herbicide where corn is being grown continuously, or where the area need not be planted for more than a year. Atrazine would injure most other crops, even into the following year. Treatment affects new plants from germinating tubers, but not dormant nutsedge tubers.

**Amitrole** sprayed on the leaves of fast-growing plants moves into the roots. Autoradiographs show that it is translocated into the tubers and seeds of nutsedge. Tubers containing amitrole rarely grow and seed germination is decreased. Applied when nutsedge shoots are about 5 inches tall, it kills intact tubers attached to the mother plants. It also interferes with chlorophyll formation. When the leaves become white, treated areas should be cultivated, then resprayed when dormant nutlets germinate. Amitrole is *not* selective, and is therefore appropriate only for uncropped land.

Where nutsedge occurs in lawns and so cannot be treated with either atrazine or amitrole, the crabgrass killers **DSMA**, **CMA** or **AMA**, used repeatedly, will kill the tops and gradually reduce the stand of nutsedge.

In general, any treatment—cultural or chemical—tends to reduce the formation of new tubers. Slowly, over a period of years, an infestation can be cleaned up. The most important practice in controlling nutsedge is to prevent the plants from forming new tubers. ♦

# VERONICAS

## *Blue-eyed problem plants challenge lawn-makers*

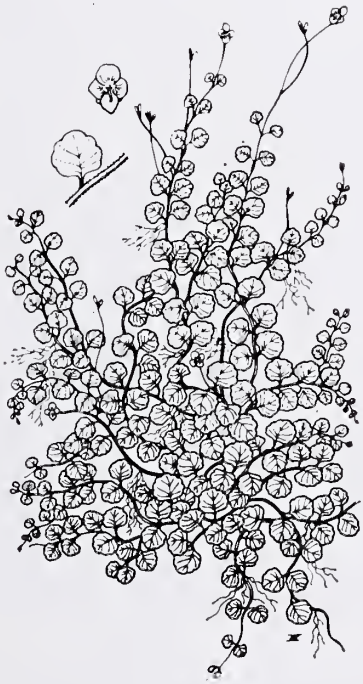
**Barbara H. Emerson**

AN unfamiliar little creeping plant with small bright blue, veined flowers and scalloped yellowish-green leaves is defying many homeowners in the Middle Atlantic states. Known only by its botanical name, *Veronica filiformis*, it is one of the speedwells, and a member of the same herbicide-resistant family as snapdragons and toadflax. Its advent is so recent that it is listed in few plant manuals of the eastern United States.

This seemingly delicate native of Asia Minor was introduced for rock gardens, but has escaped into lawns where it has become a successful competitor for space. Apparently the population in this and northern European countries has increased solely by vegetative propagation, because *V. filiformis* is self-sterile and sets no seed. It spreads freely by filamentous runners. Patches of it enlarge 8 inches or so a year, and develop rapidly into solid sheets where turf grasses formerly grew.

When this invader became a serious problem to professional turf growers a few years ago, Dr. J. F. Cornman of Cornell University carried out a series of tests to find a selective killer. Only one, endothall, helped. For good control, two successive applications are needed, but even then the veronica is sometimes erratic in its response. Moreover, bentgrass and others may be injured by the endothall, and 2,4-D must be added if dandelions and plantains are to be controlled at the same time. An ideal veronica-killer is yet to be found.

In the meantime, as herbicides eliminate the more sensitive weeds, other veronicas are appearing in lawns. Corn speedwell (*V. arvensis*), one of the few annual veronicas, is sometimes found where chickweed used to grow in turf. The smooth oval leaves of the more familiar thyme-leaved speedwell (*V. serpyllifolia*) form small patches of dark green and are relatively inconspicuous. Bird's-eye or germander speedwell (*V. chamaedrys*) is larger and looser-growing, although mowing reduces the size of its parts and makes it more compact. It has sapphire-blue flowers and somewhat triangular dark green leaves. The common speedwell (*V. officinalis*) with larger, rounded, hairy leaves, makes a pleasing ground-cover in thin woodlands.



**Blue-flowered and dainty, this small veronica (*V. filiformis*) has eye appeal in a rock-garden. But when it smothers lawn grasses it becomes unpopular.**

Until a good control can be found, one might well be advised to consider the several merits of these low-growing plants and decide to "live and let live." ♦

# JAPANESE HONEYSUCKLE

## *Persistent use of herbicides required to combat this robust immigrant*

**Silas Little**

COUNTLESS acres of uncultivated land have been taken over by Japanese honeysuckle (*Lonicera japonica*). On open sites it sometimes forms dense mats of twisted vines 2 or 3 feet tall, overrunning more desirable plants and making walking difficult. In wooded areas it climbs shrubs and trees, often weighing down and deforming saplings.

### Establishment and Growth

Japanese honeysuckle spreads in two ways—by sending out long runners from existing root systems and by establishing new seedlings. Birds, eating the fruit, are probably responsible for the long-distance spread of the plant. The initial growth of seedlings is slow, but by the third or fourth year they may be well enough established to send out runners 4 to 8 feet long. An individual seedling may send out four to seven runners.

Growth from established root systems is much more rapid than that of new seedlings. Where runners have been killed by herbicides, new root sprouts grow rapidly: the total length of laterals and sublaterals produced by one sprout in one year was 46 feet; and the average growth of marked sprouts was 25 feet. The honeysuckle can usually regain its original density within two years.

While heavy shade prevents the establishment of thick mats of honeysuckle, scattered runners can become established and persist. If the shade is reduced by cutting overstory trees, the honeysuckle responds quickly, developing a mat of vines within a year or two.

Even though honeysuckle recovers rapidly after being severely damaged, elimination of an infestation is possible. The slow rate of reinvasion by new seedlings is one of the few bright spots in the problem of controlling this vine. The experience of foresters may be helpful to rural property owners whose land is being overrun by Japanese honeysuckle.

### Possible Methods of Control

***Clean cultivation.*** Scattered runners can be pulled up by hand. A bulldozer equipped with a root rake can eliminate dense mats, though some scattered sprouts usually regenerate. Repeated mowing will hold the vines in check, but will not eliminate them.

***Herbicides.*** If rocks, trees, steep slopes or streams make these methods undesirable, weedkillers may be the most feasible method of control. In experiments conducted by the Northeastern Forest Experiment Station, several have proved effective on honeysuckle in varying degrees.

Out of these experiments, the following method of controlling Japanese honeysuckle is recommended for owners of small properties:

(1) Use a low-volatile 2,4-D in a high-volume spray to reduce the possibility of damage from volatility and drift. Either an emulsifiable acid formulation (such as Weedone 638), or any of the low-volatile ester formulations can be recommended.

(2) Mix at the rate of 4 to 8 pounds of the active ingredient in 100 gallons of water. The 8-pound rate is usually more effective.

(3) Thoroughly wet all honeysuckle foliage within 4 feet or so of the ground. If vines are climbing over trees or shrubs, cut or pull down those extending above 4 feet. In the initial application use about 100 gallons of the spray mixture per acre. Although this treatment is most effective on hot clear days in the period between late May and early September, early-fall applications work almost as well, and the result-

Typical growth of Japanese honeysuckle in an open stand. Besides wrapping around the trees to a considerable height, vines form a mat 3 feet thick.

ing brown foliage will be less noticeable then.

(4) At annual intervals repeat the spraying. Volumes required then will be less, but more care will have to be taken to find and treat scattered runners. Three or four treatments are usually sufficient to eliminate this honeysuckle.

While two new materials, picloram and dicamba, are highly effective on Japanese honeysuckle, neither is recommended at present. Foliage sprays of either may be highly damaging to adjacent vegetation, and an effective picloram treatment may have so much residual effect that the establishment of other plants is prevented for a year or more. If used, they should be handled only by trained operators.

If planted where it cannot spread—as in a city garden—Japanese honeysuckle can be an asset as a vigorous climber or ground cover, but in other situations it becomes an overwhelming pest that invites eradication. ♦

Three years ago this foreground was covered with Japanese honeysuckle. Three annual sprays with 2,4-D have eliminated it.

*Author photos*

# RAGWEED AND POISON IVY

*These irritators cause human ailments that can be eliminated only with the destruction of the plants*

**John Zemlansky**

## Ragweed

A HAYFEVER sufferer, being treated by an allergist, noticed a striking picture of a large plant on the office wall. (It was of giant ragweed.) She asked the name of the plant. "*Ambrosia trifida*," replied the doctor in a professional tone. "You know, doctor," she said, "I have such a plant growing outside my bedroom window!" Had she removed the plant when it was young, she might not have needed to be in the specialist's office that day.

All year long, but especially just before the pollen-producing season for ragweed, property owners, tenants, gardeners, and municipal and highway officials are urged to spray ragweed plants with 2,4-D to kill both the common species (*Ambrosia artemisiifolia*) and the giant kind. The plants are the most prolific producers of irritating pollen. Persons who are sensitive to it develop so-called "hayfever". Ragweed plants liberate billions upon billions of pollen grains into the areas where people live, work, play, or travel to and from their places of employment. Since hayfever and the asthma that often results from it are considered by some to rank fourth among chronic diseases in the United States, it is important for the general health of the populace to eradicate every possible plant of ragweed. Yet the admonitions go unheeded year after year.

Eliminating ragweed is a simple task with such chemicals as 2,4-D. While herbicides must be used with care to prevent injury to desirable plants, a rose bush or other plant that may be damaged by drift from the spray can probably be replaced for less than the treatment fee and traveling expenses to the allergist's office.

The common or dwarf ragweed grows to a height of at least 3 feet. It has green, fern-like, deeply cleft leaves with tiny greenish-white flowers in long terminal spikes. The giant ragweed, sometimes called by other less common names, grows from 6 to 10 feet high and has large one-, three-, or five-lobed leaves. The flowers of this are also greenish-white in long terminal spikes. During precise periods in August and September, ragweed throws off huge quantities of dusty yellow pollen. When susceptible persons are exposed to this pollen, they suffer severely with sneezing and eyes tearing. The great are not excepted. Daniel Webster wrote on August 15, 1832, "In seven days I shall begin to sneeze and blow my nose, and the first week of catarrh is most severe." A month later, he wrote, "I am in the midst of my very periodical catarrh or hay fever or whatever they wish to call it. I read nothing and hardly write anything but signatures. The disease is depressing and discouraging."*

Ragweed is especially prevalent in areas in which the ground surface has been recently disturbed. This may result from new housing construction, erosion, new road construction, grading operations or any other activity which leaves the surface of the soil bare. Ragweed is found often around new housing developments before landscaping has taken place.

Those who would like complete directions for control of ragweed may send to the Extension Service, College of Agriculture, Rutgers—the State University, New Brunswick, New Jersey, for Leaflet 238 entitled *Ragweed and Its Control.* This leaflet, prepared by the late Dr. Donald A. Schallock, Associate Extension Specialist in Weed Control, gives an excellent summary of the ragweed control

*Public Health News, Volume 31, Number 6, page 164, June, 1950.

Common ragweed *(Ambrosia artemisiifolia)* is a major source of hayfever when its pollen is flying in late summer. Spraying with 2,4-D is urged upon all who find the plant on their premises.

Giant ragweed *(Ambrosia trifida)*, often growing taller than a man, is an equally vicious cause of suffering at pollen-shedding time. It, too, should be sprayed away, wherever it grows.

measures necessary for a person or a municipal or county official in planning and operating a weed control program.

### Poison Ivy

Poison ivy (*Rhus radicans*) is a beautiful plant with glistening leaves. It grows along hedges, climbs on trees, clambers over stone walls and fences, and appears along roadsides, on playgrounds in cities and in secluded country areas. Occasionally it appears in ornamental plantings where it is prized by an unsuspecting owner. Enthusiastic flower arrangers innocently gather its attractive whitish fruits. In autumn, the leaves turn brilliant red, striking enough to use for indoor decorations—but beware!

## RAGWEED POLLEN

It is the freshly-emerged pollen of ragweed that is most irritating. The background pollen traveling in the atmosphere (present at high elevations at all times and in all weather) does not affect the sensitive person. For him, the critical point is at nose level, not a few hundred feet or several miles up in the atmosphere.

Studies have shown that concentrations of pollen grains in the air are not uniform. The pollen grains settle out and drop to the ground and become unviable. They do not have wings or sufficient power to take off again.

The living pollen grain, which is a single cell, is affected by atmospheric conditions at all levels. It, too, may have responses to other air pollution existing in the atmosphere and may, essentially, be incapable of causing further allergic reactions.

*Roche photos*

**"Leaflets three, let it be"—this is the warning for poison ivy. Waxy gray berries appear in autumn. All parts of the plant are poisonous to the touch.**

At all times of the year, all parts of this charmer except the pollen contain an unvolatile oily substance which provokes irritation ranging from reddened itchy skin to "weeping" blisters. The non-climbing poison oaks (*Rhus toxicodendron* and the western *R. diversiloba*), have the same effect.

Poison ivy can affect susceptible persons through direct or secondary contact. A dog or cat may wander through a bed of poison ivy, then come to its owner for an affectionate pat. Or a ball or stick which has inadvertently landed in a poison ivy plant may be retrieved by the dog. The animate or inanimate objects alike can cause the characteristic inflammation. Any plant part taken internally can produce a severe or fatal case of ivy poisoning. Moreover, droplets of the toxic substance floating in smoke from burning poison ivy are equally dangerous.

The substance is difficult to remove from skin or other surfaces with yellow soap or alcohol, and is so persistent that dried sap has been known to remain dangerous for years. There is a report that contaminated clothing sent from 500 miles away affected a child living where poison ivy is unknown. Reinfection from shoes and other clothing, and from gardening or hunting implements, is more frequent than is commonly realized.

There is no complete immunity or known cure, and sensitivity is increased with repeated exposure. However, desensitization is possible, and the symptoms can be calmed by a number of commercial lotions and creams. Some of them embody a substance from a plant long used for the purpose by Indians—jewelweed or touch-me-not (*Impatiens capensis*).

Prevention is better than the need for a cure, and the first rule is to learn to recognize and avoid the plant. This is sometimes difficult because its growth habit and leaf form are so variable. Poison ivy may grow as a low shrub in full sun, or as a creeping or high-climbing vine. Each leaf consists of three leaflets which at maturity range from two to several inches in length. They are somewhat oval, usually pointed at each end, and generally more or less irregular in outline. They are bright red when they first unfold. An old saying, "Leaflets three, let it be," is a good phrase to use when instructing others in the identification of this plant even if it leads to suspecting a harmless plant it resembles,

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A 1966 booklet on "Poison Ivy, Poison Sumac and Other Rash-Producing Plants" by John M. Kingsbury has been issued at Ithaca, N. Y., as Cornell Extension Bulletin 1154.

such as Virginia creeper with five leaflets, or Boston ivy, generally with three-lobed leaves. The latter vines climb by sucking discs on their tendrils, rather than by roots, and have bluish black fruit.

Poison sumac (*Rhus vernix*), found as a large shrub or small tree in moist situations in eastern United States, also has whitish fruits, and is poisonous to touch. The red-fruited shrubby sumacs are not poisonous.

Chemical weedkillers such as 2,4-D, 2,4,-5-T, or amitrole† control poison ivy. All move throughout the plant. This type of treatment is much more satisfactory than hazardous attempts at removal by digging or pulling.

Poison ivy is particularly sensitive to amitrole, which can be sprayed on vines growing up large tree trunks since it does not penetrate the rough bark of older trees. For about a week after treatment, the only evidence of response is brown dots on the poison ivy leaves. Then they begin to droop, and in another two weeks or so become as brown and dry as though the stems had been cut.

If there is regrowth from unaffected bits of root or from seeds, it should be treated to complete eradication. Treatment with any of the above compounds should be carried out strictly according to the instructions the manufacturer has provided on the label. ♦

*From "Poisonous Plants of the United States" by W. C. Muenscher (Macmillan, 1939)*

Poison sumac (*Rhus vernix*, also called *Toxicodendron vernix*) is a tall, wet-ground shrub. Like poison ivy, it gives blisters to most persons who touch it. For all such plants a spray of 2,4-D, 2,4,5-T or amitrole, applied from a discreet distance, is the safest, surest method of elimination.

† Amitrole is often referred to or may be sold as amino-triazole.

Poison ivy (*Rhus radicans*) grows as a vine over trees, shrubs, walls or ground.

Pacific poison oak (*Rhus diversiloba*) is a low shrub with rounded leaf lobes.

# AQUATIC WEED CONTROL

## *State regulations should be checked before using herbicides*

**Jason M. Cortell**

INTEREST in control of aquatic weeds has developed with increased pressures on public water supplies, recreational ponds and lakes, navigational waterways, and irrigation and drainage systems. Research workers and industry alike have responded vigorously in an attempt to find and develop safe, effective and economical methods by which these undesirable plants can be controlled.

Aquatic weeds will grow in practically any body of water where light and nutrients are adequate. Many streams, rivers, ponds and lakes exhibit luxuriant growths of aquatic weeds and algae as a direct or indirect response to the discharge of raw sewage or treated effluent (seepage included) into a river system or onto a watershed. Unpolluted bodies of water may also exhibit infestations of these plants, for they are able to utilize natural nutrients as well as the products of pollution.

In general, no one section of the United States has a priority on aquatic weed problems. In the Northeast, submerged and floating plants infest the largest of lakes and the smallest of private ponds alike. Throughout the southern states, floating vegetation has produced a history of clogged waterways and drainage systems. In the West, irrigation systems and farm ponds are plagued by aquatic weeds which reduce water flow and storage capacity.

Equipped with the latest chemical herbicides developed especially for aquatics, federal, state and local groups have set in motion a considerable effort to bring under control these aquatic pests which restrict vital water usage.

Undoubtedly the most extensive single effort in controlling undesirable aquatic plants over the past thirty years has been made by the United States Army Corps of Engineers. With industrial research and local cooperation, they have fought and considerably slowed the spread of water-hyacinth throughout the South, particularly in Louisiana and Florida.

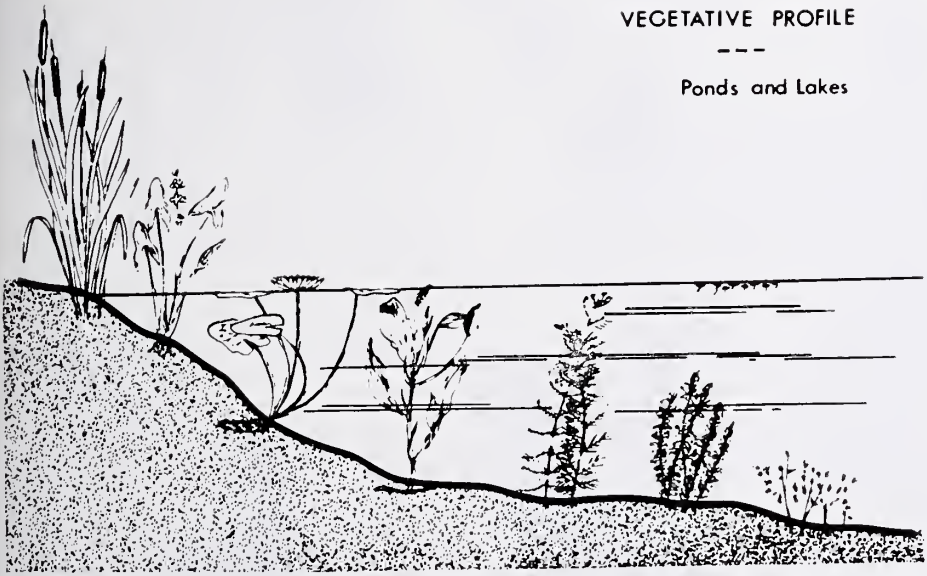
Other federal agencies involved in aquatic weed control research are the Agricultural Research Service (U. S. Department of Agriculture), Fish and Wildlife Service (U. S. Department of the Interior), Public Health Administration (U. S. Department of Health, Education and Welfare) and the Tennessee Valley Authority. These agencies have given considerable assistance and support to many fine state programs, such as those currently under way in New York, New Jersey, Massachusetts and Florida.

On the local level, cities and towns, as well as private lake associations, have undertaken efforts to clean their recreational ponds and lakes of troublesome and sometimes hazardous weed growth. Odor- and taste-producing algae are continuously under attack by municipal water supply personnel in an effort to maintain the highest possible quality in our public water supplies.

### Weed Identification

The most essential element in controlling aquatic vegetation is proper identification of the target species. Aquatic weeds include an array of extremely diversified groups which range from simple one-celled algae to highly developed flowering plants.

Classification by habitat greatly simplifies identification of these diverse plants for purposes of control. A plant growing with all or most of its vegetative parts below the water surface is termed a *submersed* plant. A plant which is either




**The different groups of aquatic plants are illustrated here. At left, plants that rise above the water *(emersed plants)*: cattail and arrowhead. Next and at upper right, *floating plants:* waterlily and duckweed. The remaining specimens are *submersed plants*—those that stay beneath the water's surface: left to right, pondweed, water milfoil, elodea, and an alga *(Chara)*.**

rooted or anchored below the water surface but has its vegetative parts above the water surface, unaffected by the rising or lowering of the water level, is called an *emersed* plant. A rooted or anchored plant growing with most of its vegetative parts above the water surface and free floating is referred to as a *floating* plant.

If a more specific identification is required, it is best to check with a reliable text or key. Two excellent sources are Norman C. Fassett's *A Manual of Aquatic Plants*[1] and W. C. Muenscher's *Aquatic Plants of the United States*.[2] Several federal publications and state handbooks are also available, and many chemical manufacturers have excellent guides which can be obtained on request.

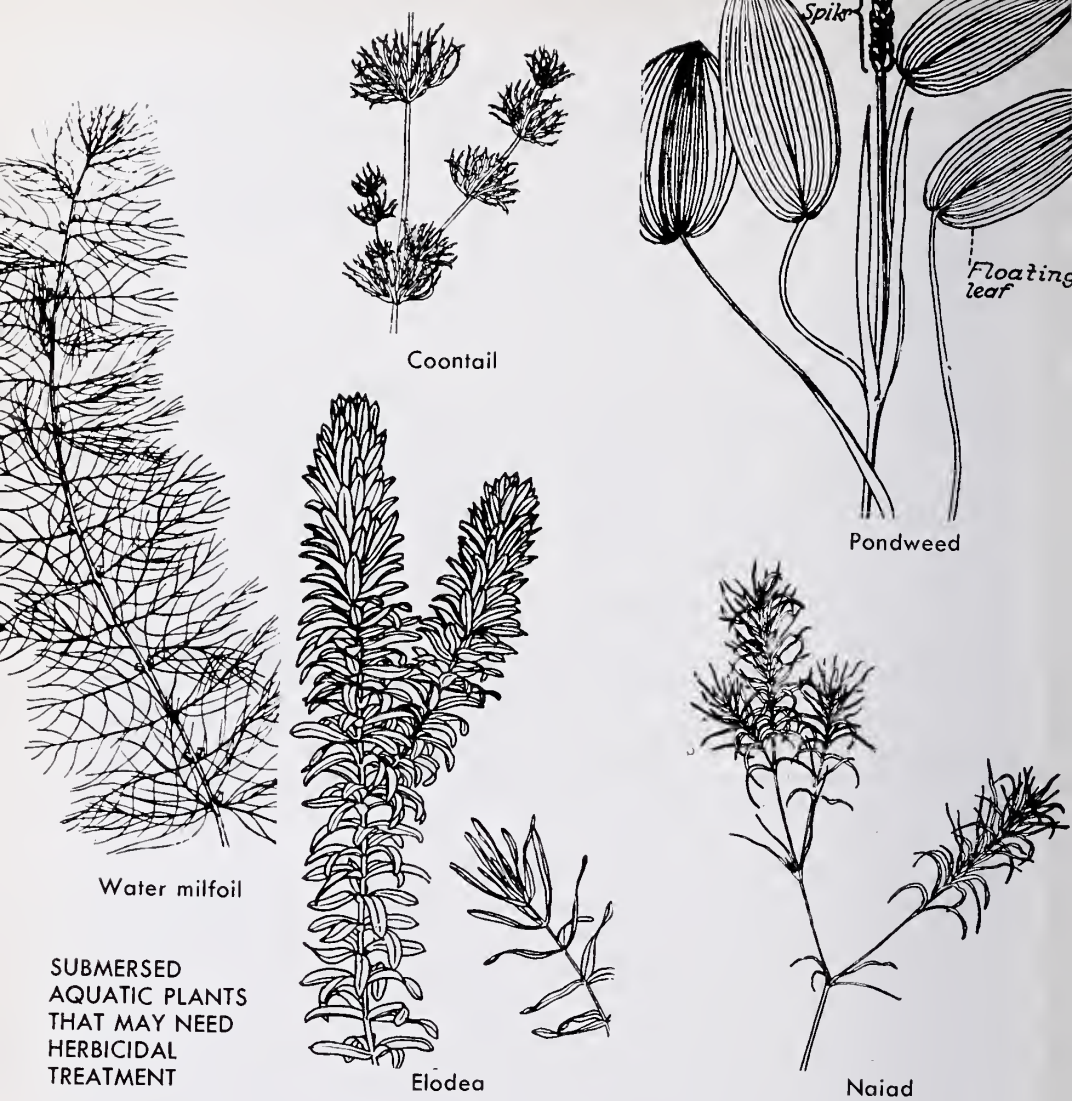
After the weed profile of the area has been determined and the appropriate aquatic herbicide has been selected, the next important step is to determine accurately the size and depth of the area to be treated. This is important in order to apply precisely the right amount of chemical.

After the acreage or acre-feet of the water has been determined, it is a simple matter to multiply this figure by the recommended dosage to obtain the amount of aquatic herbicide required for the treatment. It is important not to use more chemical than needed. While safe at the recommended dosage, a chemical could be toxic to desirable aquatic flora and fauna if used in excessive amounts.

Since fish breathe in oxygen from the water, and since decaying weeds use up oxygen, something must be done to maintain a proper water-oxygen ratio. It is best therefore to treat not more than half of the total area at one time. Open-water applications should be staggered. The weedkiller can be spread in lanes 50 to 100 feet wide, leaving buffer strips the same width between them. These can then

[1] McGraw-Hill, New York, 1940. Drawings on pages 70, 72 and 73 are taken from this book.

[2] Comstock Publishing Company, Ithaca, N. Y., 1944.




SUBMERSED AQUATIC PLANTS THAT MAY NEED HERBICIDAL TREATMENT

be treated when vegetation in areas treated first has disappeared. During the growing season, weeds decompose during a 2- to 3-week period following treatment.

## Submersed Plants

**Water milfoil** (*Myriophyllum* species)

A vigorously growing aquatic plant, found throughout North America in both acid and alkaline waters. Fine, feather-like leaves emerge from a central stem. It is always rooted and grows at depths up to 20 feet. Quite easily controlled by several different chemicals.

**Treatment**

1. Aqua-Kleen 20 (granular 20% 2,4-D ester) at a rate of 100 pounds per surface acre. This chemical is applied easily by means of a hand-operated seed spreader, or, if large quantities are required, by a boat-mounted aeri-blower or a helicopter.

2. Silvex (4 pounds active ingredient per gallon at the rate of .7 gallon per acre-foot). Can be applied by hand or back-pack sprayer or by means of a boat-bailer attached to an outboard motor. Silvex is best diluted before application to prevent "hot spots" which can be toxic to certain fish.
3. Diquat concentrate can be poured directly from its plastic container at a rate of 1 gallon per surface acre. Its use is limited to water which is relatively free of silt or turbidity, as it is de-activated by these deposits.

**Elodea** (*Elodea canadensis* and *E. densa*)

Found in canals, streams and lakes throughout North America, growing in lush quantities along the bottom of a water body. In late summer it may come loose to form large floating mats which can defy the most powerful outboard, halt the most determined centerboard or snag the most weedless fly. Control, fortunately, is achieved readily in the Northeast, although the weed is more resistant farther south.

**Treatment**

1. Aquathol Plus as a liquid at 1 gallon per acre-foot; in granular form, at 26 pounds per acre-foot.
2. Diquat at a rate of 2.1 gallons per acre-foot.
3. Sodium arsenite or Fenac. If either of these is considered, manufacturer's recommendations and state regulations should be investigated first.

**Naiad** (*Najas flexilis* and *N. guadalupensis*)

Small plants with narrow, opposite leaves and simple, inconspicuous flowers, found in streams and canals throughout the South and north to Maine. Controlled effectively by several materials.

**Treatment**

1. Aquathol Plus liquid at 1 to 1⅔ gallons per acre-foot or 50 to 70 pounds per acre-foot of granular material.
2. Diquat at 1 gallon per surface acre.
3. Sodium arsenite (40%), 6.8 gallons per acre-foot.
4. Fenac, a 5% granular herbicide, has been used successfully at a rate of 300 pounds per surface acre following draw-down of the water body. It is broadcast over the exposed surface by either a spreader or helicopter. Treatment can take place in fall or spring, but not when the ground is frozen. Application can be made up to three weeks prior to reflooding.

**Coontail** (*Ceratophyllum demersum*)

An aquatic plant with threadlike forked leaves whorled on a central hollow stem. In the water it resembles a raccoon's tail, hence its common name. It responds very well to chemical treatment, as evidenced by the wide range of materials found to be effective.

**Treatment**

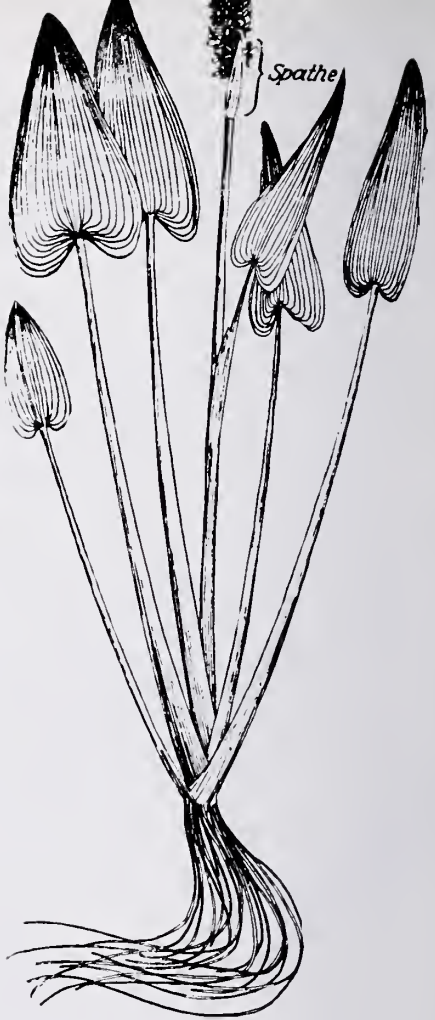
1. Aqua-Kleen granular, 2,4-D (20%), 150 to 200 pounds per surface acre; a repeat treatment may be needed.
2. Diquat, 1 gallon per surface acre.
3. Aquathol, 1.3 gallons per acre-foot.
4. Sodium arsenite or Atlas A (40%), 6.8 gallons per acre-foot as state regulations permit.

**Pondweeds** (*Potamogeton* species)

More than 80 different kinds grow as submersed or floating plants. Stems are jointed; leaves alternate, floating leaves often different from submersed ones.

**Treatment**

1. Aquathol at a rate of 3.9 gallons per acre-foot.
2. Diquat, 2 gallons per surface acre, where the water is clear and the plants are free of mud and silt deposits.
3. Sodium arsenite at a dosage of 6.8 gallons per acre-foot as state regulations permit.
4. Fenac 5 per cent granular after draw-down at a rate of 300 pounds per surface acre.




PLANTS WHICH ARE FAMILIAR SIGHTS ALONG SHORELINES
*Left,* the common reed whose waving plumes dominate many wet areas. *Right,* pickerelweed, which has attractive bright blue flowers.

## Emersed Plants

### Cattail (*Typha latifolia*)

Commonly found in wet marshy areas and along the shoreline of many ponds and lakes. Controlled by a foliage application of certain chemicals. An ounce or two of liquid detergent added to the spray solution aids in the wetting of the leaf.

**Treatment**

1. Dalapon 85% at a rate of 40 pounds (in 200 to 300 gallons of water) per acre. Smaller amounts can be proportioned for use in hand or back-pack sprayers.
2. Amitrol-T at a rate of 3 gallons (in 200 gallons spray solution) per acre.
3. Combination: Dalapon at 20 pounds plus Amitrol-T at 2 gallons (in 200 gallons of water) per acre, applied as a surface spray.

### Common Reed (*Phragmites communis*)

Found along the shores of lakes and streams in fresh and brackish water. A common seashore problem plant often dominating a whole marsh area. Control and treatment rate vary, depending on

**FLOATING PLANTS**
**Above, *Lemna*, one of the duckweeds, about three times natural size. Right, *Trapa*, the water-chestnut.**

whether the plant is growing in a wet marshy area or in standing water.

**Treatment**

A combination of 12 pounds of 85 per cent dalapon and 1 gallon of Amitrol-T is recommended for the marshy area, and double the rate for phragmites in standing water.

**Pickerelweed** (*Pontederia* species)

A shoreline inhabitant that roots in shallow marginal areas and develops broad heart-shaped leaves and late-summer spikes of blue flowers. Control is obtained with a foliage spray which should wet the surface of the leaves completely. Care should be taken to prevent drift, particularly in agricultural areas.

**Treatment**

2,4-D, either ester or amine salt, at the rate of 2 gallons of a formulation containing 4 pounds of active ingredient per gallon in 100 gallons of spray solution per acre. Small quantities for back-pack or hand spray equipment should be calculated proportionately.

## Floating Plants

**Waterlily** (*Nymphaea* species)

Most commonly seen as a fragrant white flower that floats among the flat, circular leaves; the flowers sometimes red or yellow. Roots are buried beneath the mud in waters up to 6 feet in depth. Where the plant is not desired, several applications of aquatic weedkiller may be required to establish long-term control.

**Treatment**

1. Aqua-Kleen (2,4-D 20% ester) is effective when 100 to 200 pounds are applied per surface acre.
2. Silvex at dosage rates of 1.4 gallons per acre-foot. Silvex may be toxic to fish if not applied evenly. Do not apply in moving waters.

**Spatterdock** (*Nuphar* species)

A floating plant with heart-shaped leaves that sometimes extend above the water surface. The yellow ball-shaped flower is also usually seen above the surface. Control may require attention over a period of years.

**Treatment**

1. Liquid silvex at a rate of 1.4 gallons per acre-foot.
2. Granular 2,4-D (20%) at 150 pounds per surface acre. Retreatment may be required within the same year to control regrowth.

**Water-chestnut** (*Trapa natans*)

A Eurasian immigrant now found throughout the eastern United States. Leaves have inflated stalks; the nutlike fruits bear two strong spines. In some areas, such as the tidal inter-zones of Chesapeake Bay and the upper reaches of the Mohawk and Hudson rivers in New York state, infestations extend over hundreds of acres.

### Water-chestnut

**Treatment**

1. Low volatile ester formulations of 2,4-D (4 pounds of active ingredient per gallon) at a rate of 2 gallons per surface acre, or 20% granular formulations at rate of 100 pounds per surface acre.
2. Amine formulations of 2,4-D are used in agricultural areas where volatility might be a problem.

### Water-hyacinth (*Eichhornia crassipes*)

A showy plant with handsome spikes of light blue flowers, restricted to the southern states by temperature limitation. It is a true floating plant and can be found in large mats which prevent navigation by covering the surface of a canal or pond.

**Treatment**

2,4-D, either as an amine salt or as an ester, applied at the rate of 0.5 to 1 gallon (4 pounds active ingredient per gallon) per surface acre. Spray solution should thoroughly wet the plants.

### Duckweeds (*Lemna minor, Spirodela polyrhiza* and *Wolffia* species)

Tiny floating plants which are an increasingly troublesome problem throughout the Northeast. Small garden pools, farm ponds, sluggish streams and rivers exhibit their dense growth. Relief can be achieved on a limited basis only.

**Treatment**

Diquat at the rate of 1 gallon per surface acre. More effective in small ponds, where regrowth can be checked, than in moving waters where reinfestation occurs continually.

### Algae

In many bodies of water the growth of the small one-celled plants known as algae presents the biggest problem. These plants multiply very rapidly and produce a green-pea-soup or paint effect in the water. Some algae infestations produce noxious odors, others impart a fishy or foul taste to drinking water, while other forms produce toxins which are lethal to fish.

Copper sulfate is almost universally used to control the microscopic algae. *Chara*, a filamentous alga, although somewhat resistant, can be controlled with higher rates. The chemical is available in large, medium and small crystals or as a powder.

**Treatment**

Copper sulfate at a rate between 1.4 and 2.7 pounds per acre-foot, depending on the hardness of the water. The higher rates (2.3 to 2.7 pounds per acre-foot) are used in alkaline waters, whereas in soft waters (less

## How to Determine Water Areas

The volume of an area to be treated can be determined by multiplying the surface area in *acres* by the average *depth in feet*. For example, a pond that has 5 surface acres of water and an average depth of 4 feet contains 20 acre-feet of water. If only a portion of the water area is to be treated, this portion can be determined in the same manner. The average depth in most ponds and lakes is about one-half of the maximum depth. It is best to take a number of soundings with a long pole or weighted line, marked at appropriate intervals with knots or other markings.

The surface area, in acres, can be calculated by multiplying the *length* in feet by the *width* in feet and dividing by 43,560 (one acre equals 43,560 square feet). Other simple geometric formulae are available for circular and triangular waters. The size of many bodies of water is available from either local records or the State Fisheries Office.

than 20 ppm hardness) a lesser amount should be used, as the higher rate may kill fish.

Copper sulfate does not control rooted water plants.

## State Regulations and Safety Tips

Many states require that a treatment permit be obtained before commencing aquatic weed control treatments. It is advisable to check with local and state officials to determine what regulations must be followed.

In ponds or other restricted non-flowing bodies of water with fish, if the weed population is heavy, it may be advisable to treat only a section at a time. Otherwise decaying plants might reduce the amount of dissolved oxygen in the water and suffocate fish.

All the chemicals approved for aquatic weed control are safe to both wildlife and human beings if used properly. Each chemical label indicates the specific restrictions as to use required by law. These should be carefully read and followed. ♦

## HERBICIDE TOXICITY

(*Continued from page* 11)

and effective education programs to put new information on safe pesticide usage into the hands of farmers and home gardeners promptly. In this regard, several useful rules suggested by the U.S. Department of the Interior for the safe use of pesticides are given:

(1) Be sure there is a real need for pesticide use.

(2) Treat the minimum necessary area.

(3) Select the chemical that will be the least dangerous to fish and wildlife but still control the target pest. Judge the danger of a chemical both by its toxicity and by its disappearance rate. Avoid chemicals that tend to accumulate in the soil.

(4) Use no more chemical than is absolutely necessary. Be sure no areas receive a double dose.

(5) Consider the carrier in which the pesticide is mixed, for some carriers are toxic to wildlife.

(6) Plan the time and location of treatment to reduce hazards. Try to avoid the main spring migration and nesting periods of birds. Do not apply near dug wells or areas from which they may be carried by runoff into other areas.

(7) Read the pesticide label completely before use.

As awareness of problems associated with pesticides increases, persons seriously concerned with sorting facts from fears will find three objective reports especially helpful. Embodying the findings of separate intensive inquiries, they can be obtained from a Congressional Representative, Washington, D. C. 20250.

The first was the report on the use of pesticides by the President's Science Advisory Committee in May, 1963. Following this, the Senate Committee on Government Operations' Subcommittee on Reorganization, chaired by Senator Abraham Ribicoff, held an extensive series of hearings and studies of interagency coordination of activities relating to the use of pesticide chemicals. A critical analysis based primarily on this material was issued as a report July 20, 1966.

The third investigation on effects, uses, control, and research of agricultural pesticides was conducted by the House of Representatives Committee on Appropriations' Subcommittee on Department of Agriculture, chaired by the Hon. Jamie L. Whitten. The staff interviewed over 185 outstanding scientists and 23 physicians having knowledge of the properties, the uses, and the known and potential benefits and hazards of the use of pesticides. This thorough and comprehensive study was reported on pages 165 to 208 of the House of Representatives Hearings, Department of Agriculture Appropriations for 1966, Part 1. ♦

# DRIFT AND VOLATILITY OF HERBICIDES

**Virgil H. Freed**

Condensed from "Oregon Weed Control Handbook," Cooperative Extension Service, Oregon State University, Corvallis, Oregon, 1965.

MANY of the herbicides in use today are so effective that even trace amounts of the chemical cause symptoms of injury on sensitive plants. In using such herbicides, it is important to prevent the chemical from reaching a sensitive crop, lest damage occur. The most likely ways in which a chemical will move from the treated area to nearby sensitive crops are through drift of spray droplets or dust particles or through volatilization. Drift of the spray droplets or dust particles can be controlled through proper application. Where volatility is a problem this can be avoided only through the choice of another chemical.

Drifting of chemicals is often misunderstood. Any formulation applied as a spray is just as likely to drift as any other, depending on droplet size and wind conditions. The smaller the particle the more likely it is to drift, and the farther it will drift. Also, the higher above the ground a particle is released, and the stronger the wind, the farther a particle will drift. The question is whether the chemical is sufficiently active or drifts in sufficient amount to cause damage. Avoidance of spray drift is accomplished by use of low pressures, high gallonages, and application during still conditions.

Volatility of a chemical is another matter. Damage arising out of the volatilization of chemicals is due to the vapors of the chemical that are formed during this process. It is only in the case of highly active chemicals such as the isopropyl ester of 2,4-D, that enough of the chemical will volatilize to cause injury to susceptible crops in the area.

Another feature of volatility is the loss of effectiveness. In this instance the volatilization may reduce the concentration of chemical on the treated site, thereby making it less effective or almost non-effective. A number of herbicides that we apply to the soil are sufficiently volatile that their effectiveness would be largely lost if not incorporated into the soil shortly after application.

It should be remembered that the higher the temperature, the more likely a substance is to volatilize. Even materials that we think of as being low in volatility will vaporize in appreciable amounts on a very hot day or from a hot surface. ♦

# HOW TO CLEAN A SPRAYER

EQUIPMENT that has been used for applying herbicides should be reserved exclusively for that purpose. Even though a few, such as amitrole, can be washed out, most are difficult or impossible to remove completely, and minute amounts of residue may deform or otherwise damage sensitive plants. If a herbicide sprayer must be used for other purposes, thorough cleaning is imperative. Here are five ways to remove hormone-type herbicides.

1. Add ½ cup of household ammonia to 2 gallons of water. Discharge a little through the nozzle. Let the remainder stand overnight in the tank. After emptying it, rinse the tank, hose and nozzle thoroughly.

2. Add 1½ ounces of sal soda to 2 gallons of water. Let stand at least 2 hours, then discharge it through the nozzle. Rinse tank well, refill with water twice, discharging water also through the nozzle. This and the ammonia treatment (above) are for water-soluble formulations.

3. For oil-soluble compounds, add 1½ cups of kerosene and a little household detergent to the sal soda mixture, and proceed as described in method 2.

*(Concluded on page 81)*

# RECOMMENDED READING ON WEEDS AND THEIR CONTROL


Avery, George S. and Elizabeth B. Johnson, in collaboration with Ruth M. Addoms and Betty F. Thomson. **Hormones and Horticulture.** 326 pages, illustrated. McGraw-Hill Book Company, New York. 1947.

Butler, J. D. and F. W. Slife. **Lawn Weeds: Identification and Control.** 27 pages, illustrated. Circular 873. University of Illinois Cooperative Extension Service, Urbana, Illinois. 1963.

Cocannour, Joseph A. **Weeds, Guardians of the Soil.** 179 pages, illustrated. Devin-Adair Co., New York. 1950. $2.75.

Crafts, Alden S. and W. W. Robbins. **Weed Control** (third edition). 660 pages, illustrated. McGraw-Hill Book Co., Inc., New York. 1962. $14.75.

DeBach, Paul, editor. **Biological Control of Insect Pests and Weeds.** 844 pages, illustrated. Reinhold Publishing Corporation, New York. 1965. $25.00.

Fairbrothers, David E., E. T. Moul, A. R. Essbach, D. N. Riemer and D. A. Schallock. **Aquatic Vegetation of New Jersey.** Part I, Ecology and Identification; Part II, Problems and Methods of Control. 108 pages, illustrated. Extension Bulletin 382. Rutgers—The State University, New Brunswick, New Jersey. 1965. $1.50.

Fogg, John M., Jr. **Weeds of Lawn and Garden.** 215 pages, illustrated. University of Pennsylvania Press, Philadelphia, Pennsylvania. 1956. $3.00.

Gibbons, Euell. **Stalking the Healthful Herbs.** 303 pages, illustrated. David McKay Co., Inc., New York. 1966. $6.95.

Isley, Duane. **Weed Identification and Control.** 400 pages, illustrated. Iowa State University Press, Ames, Iowa. 1960. $4.95.

King, Lawrence J. **Weeds of the World, Biology and Control.** 526 pages, illustrated. Interscience Publishers, Inc., New York. 1966. $15.00.

Kingsbury, John M. **Deadly Harvest.** 128 pages, illustrated. Holt, Rinehart and Winston, Inc., New York. 1965. $4.50.

Kingsbury, John M. **Poisonous Plants of the United States and Canada.** 626 pages, illustrated. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 1964. $13.50.

Klingman, Glenn C. **Weed Control: As A Science.** 421 pages, illustrated. John Wiley & Sons, Inc., New York. 1961. $8.50.

Miller, James F. **Weed Identification.** 97 pages, illustrated. Bulletin 632. University of Georgia College of Agriculture, Athens, Georgia. 1964.

Muenscher, W. C. **Weeds** (second edition). 560 pages, illustrated. Macmillan Co., New York. 1955. $10.00.

Peters, Elroy J., J. F. Stritzeke and Frank S. Davis. **Wild Garlic, Its Characteristics and Control.** 23 pages, illustrated. Agriculture Handbook No. 298. U. S. Department of Agriculture, Washington, D. C. 1965. 15 cents.

Rickett, Harold W. **The New Field Book of American Wild Flowers.** 414 pages, illustrated, 16 color plates. G. P. Putnam's Sons, New York. 1963. $4.95.

Salisbury, Sir Edward. **Weeds & Aliens.** 384 pages, illustrated. Collins, London. 1961. 30 s.

Spencer, E. R. **Just Weeds.** 333 pages, illustrated. Charles Scribner's Sons, New York. $4.50.

Tukey, H. B., editor. **Plant Regulators in Agriculture.** 269 pages, illustrated. John Wiley & Sons, Inc., New York. 1954. $6.95

Winterringer, Glen S. **Aquatic Plants of Illinois.** 142 pages, illustrated. Popular Science Series Volume VI, Illinois State Museum, Springfield, Illinois. 1966. 75¢.


In addition to the references listed above, the Cooperative Extension Service of the College of Agriculture in most states issues bulletins giving official weed-control recommendations for that state, and often other related information. Federal publications on the subject may be obtained from the United States Government Printing Office, Superintendent of Documents, Washington, D. C. 20402. Many manufacturers of herbicides also offer useful information leaflets and are glad to supply them upon request or through dealers who sell their products. ◆

# TREATMENT FOR WEEDS

| Crop | Type of Weed | Appropriate Chemicals** | Some Trade Names*** | Type of Action | Notes and Precautions |
|---|---|---|---|---|---|
| ASPARAGUS | Annual | monuron<br>simazine | Telvar<br>Geigy Simazine | Residual | Apply in spring before spears emerge. |
| | Quack grass and Bermuda | dalapon | Dowpon | Translocated | Apply after grass is 4"-6" tall. Repeat if necessary. |
| BULBS (tulips, daffodils) | Annual | CIPC | PPG Chemicals Chloro IPC | Root absorption; prevents cell division | Apply to clean ground before shoots appear. |
| | | amiben | Weedone Garden Weeder | Residual | Kills weed seedlings as they sprout. |
| BUSH FRUITS (brambles, blueberries, grapes) | Annual | simazine | Geigy Simazine | Residual, soil-acting | Apply to clean ground; prevents establishment of seedlings. |
| CABBAGE | Small annual | CDAA<br>CDEC<br>DCPA | Randox<br>Vegedex<br>Dacthal | Residual | After planting out, kills small seedling weeds. |
| CARROTS, CELERY, DILL, PARSLEY PARSNIPS | Annual except ragweed | dry-cleaning fluid<br>CDEC | Stoddard Solvent<br>Vegedex | Scorching | Kills small weeds; apply after seedlings have 2 true leaves. Flammable. |
| ONIONS | Annual | CIPC | Chem. Chloro IPC<br>PPG Chemicals IPC,W.P.<br>Superkill Chloro IPC | Soil-acting; prevents cell division | Controls purslane, chickweed, smartweed. Apply after 6" tall or at least 3-4-leaf stage. |
| | | CDAA | Randox | Residual | Apply up to 2 days before emergence. Controls grasses, pigweed, purslane. |
| PEPPERS | Annual | amiben | Vegiben Granular<br>Weedone Garden Weeder | Residual | Apply within 4 weeks of transplanting. |
| | | diphenamid | Dymid<br>Enide | Residual | Apply to clean soil after plants are established. |
| POTATOES | Annual | linuron | Lorox | Residual | Do not use on sandy soil. |
| | | dalapon | Dowpon | Translocated | Do not use on red-skinned varieties. |
| ROSES, PEONIES, ESTABLISHED SHRUBS | Annual | simazine<br>amiben | Geigy Simazine<br>Weedone Garden Weeder | Residual | Apply to clean ground; prevents establishment of seedlings. |
| | | CIPC | PPG Chem. Chloro IPC<br>Superkill Chloro IPC | Root absorption; prevents cell division | Apply to clean ground before weeds appear. |
| | | trifluralin | Treflan<br>Greenfield Grass and Weed Control | Residual | Apply during dormant period. |
| SQUASH, PUMPKINS | | amiben | Vegiben | Residual | Treat at planting time. |
| STRAWBERRIES | Annual | sesone<br>dacthal | Amchem Sesone | Soil-acting | Apply to clean soil after plants are established. |
| | Broadleaf | 2,4-D amine | Weedar 64<br>Weedkiller "66" | Growth regulator | Apply after picking but before runners form. |
| TOMATOES | Annual | amiben | Vegiben Granular<br>Weedone Garden Weeder | Residual | Apply to clean, moist soil. |
| | | diphenamid | Dymid<br>Enide | Residual | Apply before weeds germinate. |
| | | PEBC | Tillam | Volatile | Work into soil immediately after transplanting. |
| VINE CROPS (cucumbers, muskmelons, watermelons) | Annual | NPA<br>CDEC | Alanap-3<br>Vegedex | Soil-acting | Apply immediately after sowing. |

*Adapted, with permission, from the "Reader's Digest Complete Book of The Garden" (published by the Reader's Digest Association, Pleasantville, New York, 1966).
**Some of the chemicals listed are available only in bulk for commercial growers.
***Inclusion of a trade name in this list does not imply that the product is superior to others whch may not be listed.

# TREATMENT FOR WEEDS—(Cont'd)

| Situation | Type of Weed | Appropriate Chemicals | Some Trade Names** | Type of Action | Notes and Precautions |
|---|---|---|---|---|---|
| LAWNS | Broadleaf weeds: dandelion, plantain | 2,4-D and/or 2,4,5-T | Greenfield broadleaf weed killer<br>Super-D Weedone<br>Chemspar 2,4-D<br>De-Pester Dedweed<br>Weedone Lawn Weed Killer | Selective; kill most broadleaf weeds but not grass. Growth regulators; distort growth. | Most ornamentals, fruits and vegetables sensitive. Use separate applicator. Avoid drift to susceptible plants. |
| | Clover, chickweed | silvex (2,4,5-TP) | Acme Chickweed Clover Killer<br>Kansel<br>Weedone Chickweed Killer<br>Weedone Clover Killer | | Treat chickweed in fall or spring. |
| | Hard-to-kill weeds: knotweed, sheep sorrel | dicamba (banvel-D) | Scott Turf Builder<br>Super-D Weedone | Growth regulator; absorbed primarily by roots. | Keep away from trees and shrub roots. |
| | Grassy weeds: crabgrass | dacthal<br>treflan<br>siduron | Weedone Pre-Emergence Crabgrass Control<br>Greenfield Crabgrass Killer<br>Halts | Preemergence control. | Use in early spring before crabgrass seedlings emerge. |
| | | calar<br>sodar<br>PMA | Clout<br>Olin Ansar<br>Tat-C-Lect<br>Weedone Crabgrass Killer | Postemergence control. | Best used during cool, moist weather. |
| | Perennial grasses: muhlenbergia, tall fescue, quack grass | amitrole | Weedone Spot Grass and Weed Killer | Prevents chlorophyll production. Semiselective | Disappears from soil rapidly. |
| PATHS, FENCE ROWS, WASTE AREAS | General weed growth | simazine | Geigy Simazine<br>Pentrox Simazine | Sterilant absorbed by roots; remains in soil all season. | Apply to clean cultivated ground; prevents weed-seed germination. |
| | | amitrole and simazine | Amizine*<br>X-All* | Translocated plus residual herbicide. | Kills existing plants and prevents reestablishment for a season. |
| | | diuron<br>monuron | Karmex<br>Telvar | Sterilants absorbed by roots; season-long control. | Controls most shallow-rooted weeds. Avoid application over roots of desirable trees. |
| | Bindweed | 2,4-D and/or dicamba | Esteron 99<br>Weedone LV-4<br>Super-D Weedone | Growth regulators. | Avoid drift to desirable plants. Respray if necessary. |
| | | benzac | Benzac 354 | Non-selective sterilant. | Absorbed primarily by roots. Will injure or kill desirable plants in treated area. |
| | Brambles, incl. dewberry | 2,4,5-T | Esteron 2,4,5-T<br>Weedone 2,4,5-T | Growth regulator. | Spray thoroughly. Treat regrowth. Protect sensitive plants. |
| | Poison Ivy, honeysuckle, thistle | amitrole | Weedone Poison Ivy Killer<br>Amino Triazole Weed Killer | Absorbed by leaves; excellent translocation. | Slow but efficient. Leaves often turn white.. |
| | Quack grass and other weed grasses | dalapon | Dowpon | Translocated; pre- and post-emergence. Nonselective. | Mix spray immediately before application; corrosive to iron. Remains in soil 60 days or longer. |
| | | amitrole | Weedone Poison Ivy Killer<br>Amino Triazole Weed Killer<br>Weedazol | Absorbed by foliage; inhibits regrowth. | Dig whitened growth under. Respray any green growth. |
| | Trees (cherry, sumac, sassafras ailanthus) | 2,4-D and/or 2,4,5-T | Esteron Brushkiller 2,4,5-T<br>Weedone Brushkiller 32<br>Stauffer 2,4,5-T ester | Growth regulators. Selective. | Desirable plants may be sensitive; avoid spray drift. |

*Amizine and X-All are combinations of amitrole and simazine which are very effective in controlling weeds in driveways, patios, tennis courts, fence lines and stone walls.
**Inclusion of a trade name in this list does not imply that the product is superior to others which may not be listed.

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| all grasses (to start anew) | dalapon | 25 |
| | amitrole | |
| weed grasses in general | CSMA | 18 |
| | CMA | |
| | AMA | |
| | amitrole | 25 |
| | *pre-emergence* | 18 |
| | Azak | |
| | Balan | |
| | Bandane | |
| | Betasan or Presan | |
| | Dacthal | |
| black medic | silvex | 18 |
| broadleaf weeds | 2,4-D | 14, 18 |
| | 2,4,5-T | |
| | silvex | |
| | simazine | |
| | atrazine | |


*It is considered here, as elsewhere, that a particular "weed" may be a desirable plant. It becomes a weed only when it is growing where not wanted.

**Names with capital letters are trademarked; small letters indicate common names.

| | | |
|---|---|---|
| Canada thistle | 2,4-D | 58 |
| chickweed | silvex<br>dicamba<br>mecoprop | 14 |
| clover | silvex<br>dicamba<br>mecoprop | 12, 14, 18 |
| crabgrass | *pre-emergence* | |
| | Azak<br>Bandane<br>Betasan<br>Dacthal<br>DCPA<br>Tupersan<br>Balan<br>Chlordane<br>Presan | 14, 20 |
| | *post-emergence* | |
| | DSMA<br>CMA<br>AMA<br>PMA | 14, 22 |
| creeping beggarweed | silvex | 18 |
| dandelion | 2,4-D | 14 |
| knotweed | dicamba | 14 |
| plantain | 2,4-D | 14 |
| sheep sorrel | dicamba | 14 |
| veronica | endothal | 61 |
| wood-sorrel | 2,4,5-T<br>silvex | 18 |
| yarrow | dicamba | 14 |
| PEONIES | | |
| weeds in general | simazine | 30 |
| annual weeds | Dacthal<br>Chloro IPC | 30 |
| STRAWBERRIES | | |
| | *after transplanting* | |
| weeds in general | sesone, alone or with DCPA or diphenamid | 41 |
| annual weeds | diphenamid | 41 |
| weeds in general | *pre-emergence* | |
| | Dacthal | 40 |
| chickweed | 2,4-D | 41 |
| henbit | DNBP | 43 |
| SWEET CORN | | |
| weeds in general | atrazine | 33 |
| Canada thistle | atrazine plus 2,4-D | 58 |
| TOMATOES | | |
| weeds in general | Amiben<br>CDEC<br>diphenamid<br>trifluralin | 35 |
| VINE CROPS (cucumber, squash, pumpkin, melon) | | |
| weeds in general | Alanap-3<br>Vegiben<br>Vegadex<br>Dacthal | 38 |
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| annual weeds | trifluralin<br>diphenamid<br>Dacthal | 31 |
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| bindweed | 2,4-D | 32 |
| mugwort | Casoron | 32 |
| quackgrass | Amizine<br>dalapon<br>Casoron | 32 |
| brambles | 2,4,5-T | 45 |
| Canada thistle | 2,4-D<br>amitrole | 58, 59 |
| Japanese-bamboo | dicamba<br>picloram | 56-57 |
| Japanese-honeysuckle | 2,4-D | 62-63 |
| poison ivy | 2,4-D<br>2,4,5-T<br>amitrole | 65 |
| ragweed | 2,4-D | 64-65 |

## How to Clean a Sprayer

*(Continued from page 76)*

4. For either oil- or water-soluble formulations, add 10 ounces of lye to 2 gallons of water. Follow directions as for sal soda.

5. Add 1 ounce of powdered, activated charcoal* and 1 ounce of household detergent to 2 gallons of water in the sprayer. Shake the sprayer for a minute or two, then discharge the solution through the nozzle.

Because even rinse water can damage plants it touches, it should always go down a drain. For similar reasons, empty herbicide containers should be disposed of with care. They should never be reused or burned, but they may with safety be buried in a plot that is free of garden plants. ♦

*See footnote, page 43, for the source of activated carbon (charcoal).

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BROOKLYN BOTANIC GARDEN RECORD

# PLANTS & GARDENS

WINTER
1966-67

The Year's Highlights in Gardening and Horticulture

Guide to Recent Nontechnical Books and Articles for Gardeners

NEW SERIES
VOL. 22 No. 4

## AMONG THE CONTRIBUTORS

George S. Avery, Director of the Brooklyn Botanic Garden, whose interests in Japanese gardening and horticultural practices have helped to give the Botanic Garden a continuing pre-eminent educational role in the interpretation of "things" Japanese.

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# PLANTS & GARDENS

**Published quarterly**

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*Staff for this issue:*
CAROL H. WOODWARD, *Editor*
FRANCES A. DÄMM, *Secretary of Publications*
and the Editorial Committee of the Brooklyn Botanic Garden

Published quarterly at 3110 Elm Avenue, Baltimore, Md., by the **Brooklyn Botanic Garden, Brooklyn, N. Y. 11225.** Second-class postage paid at Baltimore, Md., and at additional mailing offices. Subscription included in Botanic Garden membership dues. To others, $3.00 per year ($5.00 for two years). Copyright, 1966, by the Brooklyn Botanic Garden.

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*G.S.A. photo*

Half a world away, in Hong Kong, this Chinese trained-tree ("pentsai"—the Chinese word equivalent to "bonsai") is one of many in the collection of Sir Sin Kin Tang. It was among the numerous horticultural treasures seen on the Brooklyn Botanic Garden's tour to the Far East.

THE 1966 tour to the Far East, sponsored by the Botanic Garden, left Kennedy Airport in New York in late October. Four Botanic Garden Staff members were with the party in Japan, and members of our Society from 10 different states made up the party. The main tour consisted of three-and-a-half weeks in Japan, and half the party went on for an additional 12 days in Taiwan, Hong Kong and Thailand.

We missed nothing! Highlights of the tour included the classical gardens of Japan and numerous glimpses into the daily life of the Japanese, as well as the folk arts of all the countries visited. In addition to visits to the great gardens, shrines and temples, we made a one-day pilgrimage to the Bonsai Village in Omiya, where some of the world's finest bonsai can be seen.

The tour itinerary also included Hakone, Toba, Kurashiki, and such off-the-tourist-beat places as Shodo Island in the Inland Sea where our longtime friend Kan Yashirodo greeted us; also Kiyosato where Dr. Paul Rusch has established his famous Kiyosato Educational Experiment Project, popularly known as "KEEP."

In Taiwan for four days, "extendees" saw the fabulous Chinese National Art Treasures in the National Palace Museum in Taipei. And we took the de luxe train trip to Taichung and went on southward to Sun Moon Lake by motorcoach for a brief rest. Rice paddies, tea and banana plantations and surprising industries are among the not-to-be-forgotten experiences of our brief dip into the life of 13 million increasingly prosperous Chinese. Then on to Hong Kong and the "New Territories" for four excitingly interesting days in the great Chinese city situated in the British Crown Colony.

A two-hour flight from Hong Kong took us to Bangkok, Thailand. Ancient temples; floating markets; a flight northward over the vast rice-paddy region to Chiengmai in the highlands near the Burma and Laos borders. There we visited craft villages and saw the happy rural Thai people at their best—making ceramics, silk, lacquer ware, umbrellas, etc., as their forebears made them centuries ago.

Native foods, congenial fellow travelers, excellent hotel accommodations—and last but not least, perfect weather—were among our many blessings, a happy omen for other such journeys to come. Two similar tours are being planned for 1967.—E.S.

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The Year-end
1966-67

As PLANTS & GARDENS readers have come to know, we devote the fourth issue of each year to presenting, in condensed form, articles of lasting interest and/or significance that have appeared in other publications during the year. It is part of the Botanic Garden's job to screen the year's production, and to come to you with articles that should not be missed. This is the 22nd year that our Editorial Committee has made its annual selection, and we want to thank the authors, editors and publishers of the original articles for their friendly cooperation.

In addition to the condensed "articles-of-the-year" there are two originals—to which we would like to call your special attention. Eleanor Regnery (page 13) deals with a problem that is common to all large cities, and urban dwellers will especially value her observations and suggestions for raising the level of people whose present circumstances discourage cultural development and appreciation of beauty. Starting on page 28, Dr. Francis Holmes gives us a glimpse of the scientific work that has been and is being carried out to cure virus diseases. The plants of the world are mankind's great providers, yet many virus diseases go practically unrecognized by gardeners and lay horticulturists. Every gardener who wishes to be well-informed ought to know what Dr. Holmes reports.

The word "espalier" deserves even more attention than our respected friend Jerome Eaton gives it in the opening article of this issue. Originally derived from the Italian word "spalliera" (which comes from "spalla," meaning shoulder), it should be pronounced es-pal′-yer. As adopted into the French language, it should indeed be es-pal′-yea, but we who speak the American version of English have no reason to give it anything other than a "y-e-r" pronunciation at the end. (Webster's New International Dictionary, unabridged.)

The year just past brought memorable experiences to Botanic Gardens travelers in Japan and Southeast Asia. A very brief account of the tour appears on page 2 of this issue, and accounts of Japanese gardens—and what they offer our part of the world—begin on pages 32 and 44.

George S. Avery

Director

*Ralph Bailey*

Horizontal cordon is probably the commonest and simplest form of espalier. Firethorn is used here, above raised beds of pansies, to enclose the motor court of a Long Island home. Holly bushes flank the entry.

# ESPALIERS IN GARDENS OF TODAY

## *For fruit growers, an early and abundant crop; for gardeners, creative design with plants*

**Jerome A. Eaton**

Reprinted from *House & Garden*, November 1966. © 1966 by the Condé Nast Publications, Inc.

ESPALIERING is the art of training plants to a predetermined shape through the selection and direction of buds and branches. In the small gardens of old France, where the practice and term *espalier* originated, orchardists developed espalier techniques as a counsel of necessity, for espaliering made possible earlier and more intensive fruiting of familiar species, especially apples and pears. Since the old Anglo-Saxon word, orchard, refers by definition to a walled enclosure for fruit trees, it was natural that when espaliers reached England, they should have been placed against protective walls, even though the decorative results could hardly have been anticipated. Now it is a question whether espaliers are more appreciated by fruit-growing enthusiasts or the everyday run of gardeners. At all events, under today's rules, *any* tree or shrub, with or without fruit, is fair game for espaliering.

Plantsmen of three centuries ago, whether monks, keepers of the royal grounds, or simple villagers, passed along their special techniques of espalier pruning from generation to generation. But it remained for scientific minds of more recent times to explain these techniques, predict and test the results, and record the recommended procedures. Now, all the mystery has been removed, and whatever the desired objective—production of fruit, embellishing a fence or wall, or the simple pleasure that

espaliering itself can give—this honorable and dramatic art is well within any interested gardener's competence.

In moving out of the orchard and into the garden, espaliers of all sorts have found new uses that formerly were practical for only a limited range of plants. From the walls of an orchard, for example, it is but a short remove to the walls of a house. Here, any of the geometric structural lines can be either accented or softened by an espalier. Formality can be played up or played down. And of course a well-trained espalier can create a pattern all its own. Few plants are better suited than *Pyracantha coccinea lalandi,* the orange-berried firethorn, to creating an inviting framework for an entrance door, to being trained in horizontal cordons beside a courtyard gate. In this day of built-in garages, a blank, windowless garage wall is not unlikely to present a real decorative problem, but it is one that a trained plant or series of flat-patterned plants can handsomely cure. Good plants for espaliering in such locations are, in addition to the firethorn: Asiatic dogwood (*Cornus kousa*), readily adaptable to either fan-shapes or modified U-shaped cordons; Hicks yew (*Taxus media hicksi*); Japanese holly (*Ilex crenata*); or, given sunlight, a fruit-bearing peach. An effect of balustrades and railings bordering a garden walk can be achieved quickly and easily with the fruiting arms of apple or pear cordons.

The need to set apart one area from another is just as common a problem outdoors as indoors. The best plants for this purpose depend on the degree of screening that is required. A solid fence (typically wood or brick) may offer an ideal background for an espaliered cotoneaster, for *Viburnum dilatatum,* or the lovely weeping flowering crabapple 'Red Jade'. For an airy, less impervious barrier, the espaliers alone, with a minimum of wood and wire supporting structure, serve admirably. Forms such as the traditional crisscross Belgian fence or the more complicated arcure, when trained to a simple wood-wire framework, can be created with dwarf apples or pears, with the goldenchain tree (*Laburnum watereri*) or with star magnolia (*M. stellata*). Even vines—provided they have woody stems and are not rampant in growth and do not tend to cling or twine—can be successfully adapted to almost any of the foregoing purposes. Hardy orange (*Poncirus trifoliata*), Pfitzer juniper, and small-leaved varieties of English ivy simi-

Arcure is a form of espalier characterized by gracefully arching side branches. The apples below, shown in the author's garden in Scarsdale, New York, are 'Orange Pippin'—a now rare variety.

*Ralph Bailey*

larly lend themselves to specialized espalier treatment.

Just as the beauty of espaliered trees was really a by-product of the intensive cultivation of fruit, so the revelation of unsuspected attributes of many familiar plants has resulted from the application of espalier training procedures. In fact, the simple exercise of espaliering techniques has become for many gardeners an absorbing pursuit in itself—a virtuosity that is within anyone's reach. While fruit trees are still among the species most easily adapted to training, the fruit itself may no longer be the principal objective. Blossoms, normally fostered by the orchardist as the essential precursor of fruits, are, as often as not, the culmination of an espalier's seasonal performance. Any fruit or berries that result are for the most casual kind of harvesting—if not literally for the birds.

## Basic Beginnings

Once the novice becomes familiar with the growing habits of a tree, the measures used to train it and the proper ways to maintain it come easily. The mechanics of growth in woody plants depend on the absorption of moisture and dissolved nutrients on the part of the roots, which in turn deliver the solution to the leaves. There, in the presence of sunlight and chlorophyll, food is manufactured and returned to the plant tissues, to foster growth during the current season and supply a reserve for the production of next year's flowers and fruit (fruit, berries or seeds—they are all the same to a plant). Every part of the espaliering procedure follows from an understanding of this cyclic principle, and it is not hard to translate this into the basic steps of espaliering.

## Double Horizontal Cordon

A double horizontal cordon (that is, two pairs or arms, parallel to the ground, growing from either side of a main trunk) can be created in two years. In the third year the tree can bear fruit. A one-year whip or "maiden" tree, grafted on a dwarfing rootstock (so specified in dealers' catalogues), will exhibit a restrained habit of growth that will be more easily brought into the desired form, with the end product more easily kept under control, than if "standard" trees are bought. The tree should be planted in early spring, either in a permanent location or one convenient for training (the espaliered tree may be successfully transplanted later). Set posts tall enough to carry two horizontal wires at a 30-inch total height and far enough apart—8 feet, say—to include the cordon between them. Your tree should stand just in front of the wires and midway between the posts. Immediately after planting, cut off the top leader of the whip about 15 inches from the ground (diagram 1), just above one bud that will form a new leader. The

*Jerome A. Eaton*

Six-arm cordons are well suited to espaliered grapes. This vine, trained on a picket fence, is at a farm in Maryland.

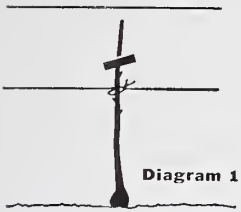

Diagram 1

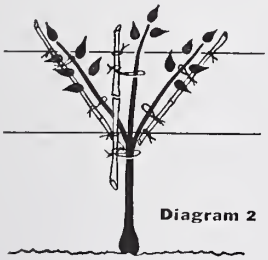

Diagram 2

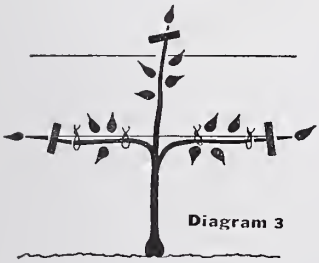

Diagram 3

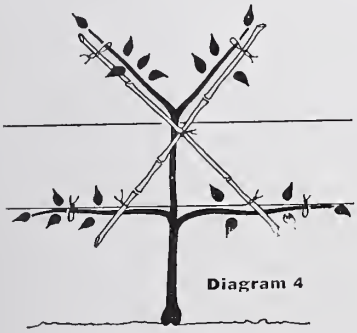

Diagram 4

next two nearly opposite buds on the whip will form the first set of arms. With your thumb, rub off all buds below these three.

During the first growing season, as the new leader and the two opposed arms develop from the three top buds, tie each to a thin bamboo cane which in turn should be tied to the wires. The new leader should, of course, be vertical and the two arms kept to a Y form for the present (diagram 2). Allow no other new growth to develop during the season on the main stem. And prune back side growth on the three new stems to leave only two buds on each shoot. Begin this policing routine about mid-July and continue it until mid-August. The first summer is devoted to structure, not fruit.

By autumn the first pair of arms (the arms of the Y) can be tied down to the lower wire. The vertical leader is of course already tied to the cane between the first and second wires. After leaf fall, the tips should be cut back a few inches just beyond upward-facing buds in order to induce thickness in the remaining growth (diagram 3). Early the second spring, cut back the leader to force two nearly opposite buds for the second horizontal tier.

The second season, of course, will see the repetition of the bracing and tying process for the two new horizontal arms. There will be no new leader, since the two topmost buds left after the spring cutback are those that are to develop into the upper arms, held in position by crossed bamboo canes (diagram 4). The second season also sees the emergence of fruiting wood (spurs that will produce flowers and fruits) on the basic structure. Control growth on the new arms as you did that on the first summer's arms. Such summer pruning provides the greatest control of form and induces the early formation of fruiting wood (as distinct from the early spring pruning, which promotes new vegetative growth). By removing excessive leaf growth during the growing season, the vigor of the tree is restrained and directed into the areas where flower and fruit buds will develop.

## Annual Maintenance

All espaliers require a certain amount of yearly care. The routine, never drastic, is spread out over the season in short spurts of attention. Unlike the tree or shrub growing under ordinary garden

conditions, which is pruned principally in the autumn, winter or spring (depending upon kind and use), espaliers are pruned mostly during and throughout the summer. Since late winter or early spring pruning is essential to the vigorous growth of new branches during the ensuing spring and summer, an espalier in the making does need early attention. But once the main structure has been formed according to the general principles above then all new side shots (termed laterals on espaliers just as on roses) should be shortened to not more than 6 inches. The form of the espalier will thus be kept sharply defined and the development of flowers and fruits will be promoted.

Fertilizing and spraying are easily accomplished because of the espalier's compact form. Fertilizers low in nitrogen are best unless such symptoms as orange-red leaves and/or undersize fruit indicate nitrogen deficiency. In well-prepared ground, this is not likely to be a problem. Spraying with a combination fungicide-insecticide formulated for fruit trees (or trees and shrubs generally) is best done fortnightly during the growing season and on a regular schedule. Waiting for troubles to become apparent may prevent thorough control. Ten or fifteen espaliers can be sprayed with a 2½ gallon over-the-shoulder sprayer in about ten minutes, not counting mixing and clean-up time for the spray tank.

*Richard Carver Wood*

Belgian fence espaliers are made with a succession of Y cordons, so spaced that a diamond pattern results. Apples and pears are especially successful trained in this style.

## Adapting the Rules

All espaliering procedures applicable to fruit-bearing plants may be adapted to any other ornamental species having similar habits of growth. Yews, for example, respond best to fan-pruning rather than to the cordons or U-shapes of the traditional espalier. Cotoneasters often lend themselves to informal espalier modifications, especially against plain walls where their texture will be particularly pleasing. Plants with both strong branch structure and compact foliage, such as firethorn and Japanese holly, will lend themselves equally well to fan or espalier pruning—or, for that matter, to free-form patterns of almost limitless variety. And of course it is in variety that the practice of espaliering comes into its own. More than most gardening practices, the techniques of espaliers are a fascinating preoccupation in their own right. Yet it must be obvious by now that this is not the complete story on the fine points of espalier form or technique. Where, then, does the enthusiast acquire proficiency and versatility in what can amount to a fine horticultural art? From books? Alas, few modern works go into much detail. But try your local library. The old books are more of antiquarian or historical interest—although they may illustrate many handsome espalier forms. There are, however, two good ways open to the beginner. One is to scout out and haunt the accomplished enthusiasts. You will find at least one in every community where interest in plants and gardens is conspicuous. The other way is by the simple process of making a start, keeping several new plants always in training, and observing the results of your efforts—including, not least, your mistakes. ◆

# INSTANT LAWNS GAIN FAVOR

## *Ready-made turf, though costly, makes good appearance and saves on labor*

James E. Bylin

Condensed from *The Wall Street Journal*, August 29, 1966. © 1966 by Dow Jones & Company, Inc.

AT a cost of $15,000, you couldn't say the Oakland (California) Raiders' new lawn is dirt cheap, But, actually, the instant lawn of 158,000 square feet was pampered to maturity for over a year on a turf "farm" 80 miles from Oakland in Patterson, Calif. When the greensward was ready, Cal Turf North, Inc., rolled up the whole thing like a carpet, trucked it to the new Oakland Stadium, and laid it down.

Cal Turf North is one of a growing number of commercial grass growers, called turf or sod men, now laying down instant carpets of green just about anywhere a bare patch of dirt is showing. Stadiums are only one type of job. Instant lawns are also springing up around homes, motels, industrial sites, schools, and in parks, golf courses and cemeteries.

The industry was born after World War II in the Midwest and Southeast, where the post-war building boom—and a ready supply of pasture and field sod—put many turf men into business. It's only been in recent years that turf has made inroads in the West where it's also becoming a booming business.

Over the years, pasture sod and other rough varieties have been giving way to carefully nurtured commercial turf, free of disease and weeds, according to the growers. "High quality nursery turf bears about as much resemblance to the old piece of pasture sod as a well-groomed registered poodle bears to an unkempt mongrel," declares one turf executive.

This doesn't mean commercial varieties can't be tough; indeed, growers can tailor their turf to extreme user needs. The Raiders' playing field, for example, was bred to withstand the pounding cleats of the 280 pound behemoths who will use it.

At first glance, an instant lawn seems horrendously expensive. Roy Cranmer, a Chicago landscape architect, says he'll lay down a 700-square-yard turf lawn for $700—but he'll seed the same lawn for $200.

However, he points out that the $200 is just a "down payment" on three years of weeding, fertilizing, reseeding, erosion control and battling the thousand other ills a new lawn is heir to. With sod, he claims, the homeowner is spared this struggle and expense.

Most of the residential part of the sod business is in new developments—where instant lawns can often be a necessity. Faced with sloping ground, poor soil and a short growing season, Crystal Bay Development Co. turned to sod in landscaping its Incline Village developments at Lake Tahoe. The homes with instant lawns are selling twice as fast as similar ones without sod.

Though small, the business of re-turfing older homes is growing. Mrs. Ethel Fenn, a Chicago landscape architect, estimates 25% of her business comes from people who want to replace old lawns. Growths of weeds and clover in the old turf discourage some homeowners, she says, so they chuck the whole thing and start over. Others are attracted by new turf grasses that require less care.

The turf men note that theirs is nearly a year-round business. Sods can be laid pretty much any time of year, but seeding generally must be done in spring or fall. ◆

*Molly Adams*

Low-growing Sargent junipers adorn the bank beside these steps the year around, their bluish coloring being especially attractive in winter.

# JUNIPERS ARE USEFUL

*A landscape architect shows how these evergreens can be effectively used along a path, by a flight of steps, in a terrace garden or in a planting on a dune*

**Alice R. Ireys**

Condensed from *Horticulture*, November 1966

JUNIPERS may be used in many different places to enhance one's property. The choice of varieties is large. They range from the low-growing ones, like Bar Harbor, 3 to 8 inches above the ground, to the tall native red-cedar seen so often in abandoned fields.

Junipers are easy to grow provided you give them sufficient sun and a soil that is not heavy. Noticing where they grow naturally, you can learn much about their likes. Keep them away from under trees, since they do not like deep shade or competition with roots, and away from water-logged soil. They will not tolerate wet feet.

The upright columnar ones may be used to accent a feature, as a windbreak or hedge, or in groups to give evergreen interest. The low spreading kinds may be used to cover rocky slopes and sandy banks, and in the rock garden. They grow in different ways. Some, like Wilton, like to grow downward, where others like the dwarf *Juniperus chinensis procumbens nana* make irregular mounds. Many change color in the winter. The berries borne heavily on some junipers are attractive to the birds.

As you select your junipers, know their habit (prostrate, spreading or upright); their texture so you can combine them

with other plants; and their winter as well as summer color.

Now, for some examples:

### Along A Path

Junipers were chosen to border a long path near a seaside home because they withstand shore conditions, require little maintenance and give a color and texture pattern. The lowest growing were planted near the edge of the path: Sargent (*J. chinensis sargenti*), and Bar Harbor (*J. horizontalis* 'Bar Harbor').

The Sargent juniper grows 8 to 12 inches high with blue-green foliage. The Bar Harbor, 6 to 8 inches in this location, has blue-green foliage which turns maroon in winter.

Behind these low spreading varieties a taller one, Andorra (*J. horizontalis plumosa*), was used to give an intermediate height. Andorra has a spreading habit, grows to 3 feet, and has a wonderful bronze fall and winter color.

The tallest-growing ones — Hetz (*J. chinensis hetzi*) and Pfitzer (*J. chinensis pfitzeriana*)—were selected to give a billowy outline to the background of this planting. Hetz has a blue-gray color more pronounced than the gray-green of Pfitzer. These broad, bushy shrubs need regular pruning to be kept within the scale of this planting.

Today most junipers are purchased in containers. So, allow space for future growth. Do not overplant. We interplanted the bare spaces for the first few years with sweet alyssum, and this made a fragrant, white groundcover that was inexpensive and most attractive through the summer months.

### Beside Steps

The junipers were chosen for their winter interest in an area by the steps and leading to the front door. The Pfitzer gives the needed height along the bank; the Sargent juniper stays lower and has a good, blue winter color.

These plants were placed 5 feet apart. It takes about four years for a 12-inch container-grown plant to reach mature size. Thereafter, it is necessary to prune only occasionally, removing the older, heavy branches in the center.*

In such a planting it is wise to keep the selection to not more than two or three sorts and select the ones that will give the proper texture and color in your planting composition.

### In a Terrace Garden

A garden designed by Clara Coffey, L. A., enclosed by a low brick wall behind which are weeping cherries, is covered with crushed stone and has weeping hemlocks and low junipers around a Chinese statue.

Junipers were selected to spread out over the stones, for they do well in such a situation and give good color. Tamarisk juniper (*J. sabina tamariscifolia*), which has a spreading or procumbent habit, is an excellent prostrate juniper with a bright green color. The leaves are needle-sharp. The second juniper is Wilton (*J. horizontalis wiltoni*), again a low, spreading form which creeps over the stones and gives color and a pattern to the little garden.

### In a Dune Garden

In creating a garden just below the dunes outside of a beach home, two beds were built, one above the other, and two kinds of juniper were chosen along with native bayberries and beach plums, which were used in clumps at the ends of the wall.

Parsons (*J. chinensis parsonsi*) and the Andorra juniper (*J. horizontalis plumosa*) were selected because of their interesting habits. Parsons juniper makes a dense mat turning a lovely bronze color. Andorra grows in horizontal fashion but turns upward at the tips. It is a rich plum color in winter and has fine summer color.

Any number of other varieties, like the shore juniper, *J. conferta*, which stays green through the winter, or any of the horizontal varieties could also have been used. ◆

*Wear gloves when pruning; junipers are prickly.—Ed.

# WHY PEONIES DON'T BLOOM

Harold Tinnappel

Condensed from *Horticulture*, October 1966

PROBABLY several factors contribute to the lack of bloom on peonies. Most difficulties can be classified under three categories: (1) environment, (2) cultural practices, (3) genetics.

## Environment

If your peony does not bloom you may discover the reason by answering the three following questions (a) Is the peony planted in a well-drained situation that receives sunshine at least six hours of the day? (b) Is it free from the competition of roots of trees and large shrubs? (c) Is it in good garden soil?

The peony will not tolerate wet feet. When planting, do not locate the plant in a low site. Be sure that the soil has been dug to a depth of at least 12 inches and then allowed to settle before the root is planted. A good clayey loam seems to suit the peony better than a sandy type. A neutral soil that is capable of raising a good crop of vegetables is ideal for the peony.

Heavy fertilization is not advisable, especially on recent plantings, but some fertilizer may be worked in about the plants after they are established. An analysis low in nitrogen (say 5-10-10) is best for this purpose.

A peony that is tall, spindly and not blooming may indicate an insufficiency of sunlight, perhaps because of nearby trees or shrubs. Interference with free circulation of air and the competition for water and nutrients may also explain a lack of flowers. Peonies should not be crowded by neighboring plants.

## Cultural Practices

During the growing season is the peony given adequate mositure? Is it kept free from grass and weeds? Is the foliage allowed to mature?

Often a grower can trace a season of few blooms to an exceptionally dry period just preceding the time when the buds should be formed. The foliage should be allowed to ripen on the plant. After a frost in the fall it should be cut to the ground, removed and burned.

Although some well-established plants manage to flourish in sod—witness some ancient plants in old cemeteries—in the first few years of its life the peony plant should be cultivated cleanly.

## Genetics

Is the variety one which has a record of blooming consistently? Some are reliable bloomers, others present a challenge even to the expert to coax into bloom. A catalog from a peony specialist will identify those varieties which can be counted upon to bloom year after year.

Good healthy divisions with three to five eyes should be purchased from a dependable grower. Then the eyes should be planted no more than 2 inches deep. This distance refers to the depth of cover after the soil has settled, not just the depth at planting time. The first winter a mound of soil over the roots should be provided.

## One More Reason

If the answers to all queries above were "Yes" and yet your peonies do not bloom, the explanation may be that your soil is infested with nematodes. If they are in your planting, it is best to start all over, not place your new roots in the same location where peonies previously grew.

Remember that if you plant a healthy division, of a good variety, in a satisfactory location and give it reasonable care, you can expect it to give you pleasure the rest of your life. Most peonies can easily outlive the gardener who plants them. ◆

# NEIGHBORHOOD PLANTING IN CHICAGO

Eleanor S. Regnery

INSPIRED by the remarkable work of Louise Bush-Brown and the Board of the Neighborhood Garden Association of Philadelphia, the Garden Study Club of Hinsdale, Illinois, undertook a similar work in Chicago.

The purpose of the program is to encourage and foster an interest in flowers and gardening in congested areas of the city. It is a "grass roots" program requiring the active participation of the residents of the block. Reaching people through a settlement or neighborhood center, the Garden Club members arrange to take blooming plants to a block on a given day with the understanding that the residents will provide their own window boxes and earth. The hope is that a touch of color and beauty will inspire pride in the general appearance of the block. If every family in the block becomes involved, it makes such a difference not only in appearances but in the neighborliness of the people, that the whole spirit of the block is changed. People not only care for their plants, but they clean up refuse, working together with their neighbors.

Four years ago we planted the first block. Through a contact with the YWCA, we were able to get acquainted with a block on the West Side of Chicago. Here substantial semi-detached houses had become overcrowded and run down. Where one family had originally lived, three or four families now occupied a

*Dave Charm*

A neighborhood project of setting out flowering plants along a Chicago street inspired a local cleanup crew to make further improvements.

house. The street was littered, the parkways were trampled and messy.

We invited some of the leaders of the block to gather one evening at the local YW, where we showed pictures and explained what we thought could be done. Their response was almost pathetic, they wanted so much to have a nice neighborhood, and yet were too apathetic to do the few necessary things to make the street attractive. They understood about providing their own window boxes and earth, and we agreed on a planting date. There was a lot of enthusiasm in the block, the residents cleaned up the streets and parkways, planted grass seed, even painted the tree trunks white. Everybody was out on planting day, a lovely sunny Saturday in early May. The children were about, also many husbands. I'll never forget the very little Negro boy who was determined to have a box of plants by the door of his family's basement apartment. Unable to make a box, he had found a little old bureau drawer and filled it with earth. He was radiantly happy, having a few red geraniums and white petunias blooming in his box. A simple lunch was served in one of the small apartments, and the resulting spirit of good will was worth all the effort.

A local greenhouse had been very helpful in supplying the plants which they let us have at cut rates. We packed the plants in small boxes with the right number of plants for one window box in one carton. We used geraniums, petunias, coleus, ageratum, and impatiens and other small annuals. We encouraged people to plant seeds among the flowers, and also gave information about cheap fertilizers and watering.

Somehow the newspapers had heard about our project ahead of time and were on hand to take pictures, so we had excellent publicity. Right away we began to get telephone calls from neighborhood centers asking how they, too, could get flowers. We arranged to take plants for 25 boxes to a block in the Pilsen area. They had done a good job of publicizing the idea and again the whole block turned out. The local priest came to bless the plants before we started, and there was a very good spirit. We learned that you have to be specific about size of boxes. Many were too shallow and some too flimsy and not securely fastened to the houses, so that they fell apart or went crashing down almost before the plants were in place. There were no trees in this second block and no parkway for grass seed, so the flower boxes were the only color and the plants in them the only growing things.

It was interesting, on going back later in the summer, to see what had happened in the neighborhood surrounding this second area. On a nearby street forty half barrels had been set out on the curb and planted with gay flowers. Where there was a parkway, the nearby residents had planted grass seed or bushes. Garbage cans had been painted and alleys cleaned up.

The following spring we undertook four new areas as well as returning to the blocks where we had been the year before. Each time there was equal enthusiasm. In one area where we took flowers there was a burned out house that had become a gathering place for big boys. The woman who was the leader of the group said to me, "If they would only take that house down, we might do something with that lot." It was a corner lot next to a small church. The next spring she called to say that the city was demolishing 'that' house. So we went to work. We got permission from the owner to use the corner for a garden. "Do it fast," the lady said, "before it is filled up with old cars." So we worked fast. A business donated fencing which the men in the neighborhood put up. We bought black dirt to spread, tried to interest a group of young women to work with us, and got what seemed to be appropriate plants for the border. Somehow it didn't work out well. No one wanted to take responsibility for the care of the lot. The plants dried up and weeds took over. We went back later with donated grass seed to find the lot littered with broken glass and empty beer cans, and the fence broken in many places. This episode had a sad ending.

The owner of the lot told the group that he was so pleased with the idea of having it used for a garden that he wanted to donate the property to the group. They accepted the papers of ownership without consulting. It was indeed a shabby gift, for there were several years of back taxes and a collapsing sidewalk for which this group was now responsible. Naturally they lost interest in the entire project.

We have done planting in 14 blocks in six different areas over the four years. Every time there was great enthusiasm with the first planting and also every time in the second or third year there has been much of a feeling of waiting for something free. Instead of a friendly cooperative planting it has turned out to be a distribution to those who were members of the block club. The time has now come for these blocks with which we have worked to take over for themselves, to try to stimulate their neighbors and to buy their own plants. We have been assured that one area will do this and hopefully others will follow suit.

Because growing flowers is such a joyful thing to do, it appeals to all, regardless of one's station in life. Therefore the Garden Club members and the residents of the blocks have been able to meet on a common ground. There is no delving into problems, nor even registering disapproval at shabbiness or litter. The flowers take care of that. Always before we have left a block after planting flowers there, we have seen at least one woman washing her windows. The future and expansion of this project depends on widening the interest among garden clubs. This is not easy to do. More often than not a club is interested in perking up the suburban station or a parking lot. This is also important and worthwhile. However, I believe that those of us who are more fortunate should expend some time and thought to brighten the lives of the thousands of people who, for one reason or another, live in squalor. The time it takes is small, the money very little, and the reward enormous. ◆

*Dave Charm*

**Children were eager planters when flowers were brought to them for the boxes they themselves had furnished. Residents of the entire area took part in the street beautification program.**

# SEASONAL HARDENING AND DEHARDENING OF WOODY PLANTS

## *Internal processes determine their susceptibility to cold at different times of year*

**Harrison L. Flint**

Condensed from *Arnoldia,* The Arnold Arboretum, Jamaica Plain, Massachusetts, November 18, 1966

EACH autumn, one of Nature's most remarkable performances takes place —and goes unnoticed. We are quite familiar with the autumnal change in foliage colors in many deciduous trees and shrubs, but unaware of even more dramatic internal changes that are proceeding at the same time and afterward in the same plants, and evergreens as well.

The internal changes, collectively called *hardening,* enable many plants to withstand sub-zero temperatures during the winter, even though the same plants would be killed by temperatures just a few degrees below freezing in summer.

For example, experimental freezing tests show that stems of common lilac (*Syringa vulgaris*) would be damaged severely by a freeze into the low 20's in mid-August. By late October, they will withstand temperatures close to zero, and by December, temperatures of —20 F. and lower will not injure them.

In spring the reverse process, *dehardening,* is brought on by rising temperatures. Stems of common lilacs, to follow the same illustration, will not be injured when exposed to temperatures far below zero in February. By mid-April they will be sensitive to temperatures as low as zero, and by mid-May they will be as tender as they were in the previous summer.

The differences in winter hardiness that we can see among species of woody plants can be explained in part by the fact that different species harden to different degrees in winter, and harden and deharden at different rates. The chart shows the approximate minimum temperatures that have been recorded in Boston (Logan Airport) and the hardening and dehardening trends of four hypothetical plant species, which we will call A, B, C, and D.

Species A begins to harden early in autumn, hardens quickly, and is slow to deharden in the spring. The line representing its hardening trend falls below the minimum temperature line at all points and so it is not prone to injury. If all plants behaved in this way, there would be no need to discuss winter hardiness as a practical concern. If we were to measure seasonal changes in hardiness in our native trees, we would expect them to behave in about the same way as species A.

Species B starts to harden in early fall but does not have the capacity to harden to the same extent as species A in midwinter. This is the way we would expect some of the landscape plants used in the southern United States to behave in our area, and is the reason for their failure here.

Species C has the capacity to harden *eventually,* but it does not harden *rapidly enough* to escape the first hard freezes of late autumn. If cold weather is unusually late, this hypothetical species may escape damage, and by mid-winter it may have had time to harden enough so that it survives the rest of the winter without injury. But in a normal season it may be killed before the end of November. Some of the less hardy azaleas behave in this way and we suspect that many other

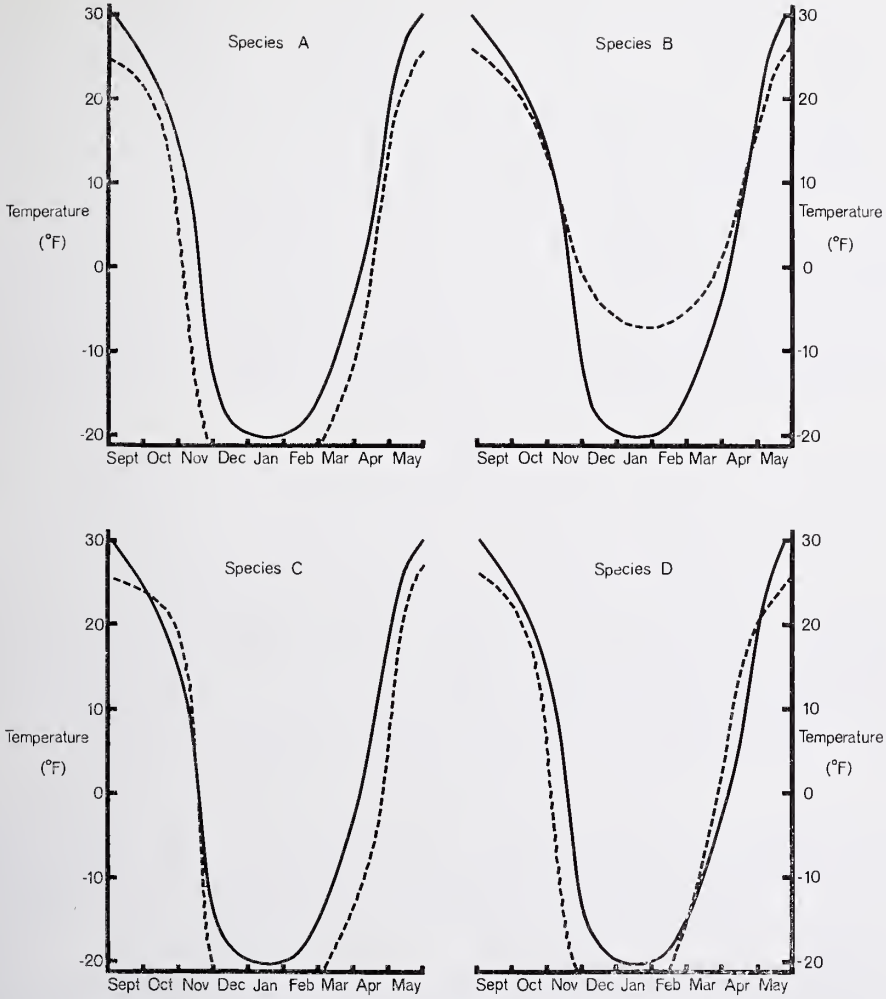


**Chart showing differences in the reaction of four types of woody plants (shown by broken lines) to seasonal changes in temperature.**

plants do also, especially when they are young and vigorous.

Species D differs from species C in that it runs into trouble in spring rather than in fall, because it dehardens too rapidly and is injured by cold snaps in late winter or spring. Peach trees and raspberry canes suffer this kind of damage in the colder areas of New England. Too-rapid dehardening may be caused by early breaking of internal dormancy or rest, the ability to begin growing at relatively low temperatures, or both of these factors.

It is easy to talk about hypothetical species and to sort them into neat groupings. Real species are not so simple—the weaknesses of two or more hypothetical species may appear together in a single plant. For example, even though we know that many real plants resemble the relatively hardy species A, we're not sure that the more tender plant species have only a single weak point. Some may even

combine all the weaknesses of species B, C and D.

Complicating things further, the vulnerability of a species depends upon the climate in which it is growing as well as its ability to harden. Thus a particular species presumably may be vulnerable at one season in one location and at a different season in another location having a different cooling trend. And still further, the rate of hardening and the time when it starts will be influenced by the climate in which the plant is growing.

All this does not mean that it is hopeless to expect to learn much about susceptible points in the hardening cycles of different species. But it does mean that information gained at one location is not necessarily valid at another.

Seasonal hardening and dehardening trends have been studied in only a few species, most of them evergreens. Clearly, there is much work to be done before the points of vulnerability of a wide range of species is known. When this has been accomplished we may be able to attack the practical problem of adapting more kinds of trees and shrubs to the colder parts of the north temperate zone on a far less empirical basis than is possible today ◆

## HOW TO SCREEN THE JUNKYARDS

Ideas for hiding ugly areas from the public gaze can often be obtained from ornamental plantings, according to Donald Wyman, horticulturist at the Arnold Arboretum, Jamaica Plain, Mass., writing in *Horticulture* for April 1966. Below, beauty-bush (*Kolkwitzia amabilis*), combined with pine, makes a heavy barrier that has beauty at every season. Dr. Wyman offers extensive lists of plants for hiding roadside eyesores in many different types of situations.

*Paul E. Genereux*

# AIR POLLUTION IN SOME AREAS HAZARDOUS TO PLANTS

**Harold M. Schmeck Jr.**

Condensed from *The New York Times*, December 27, 1966. © 1966 by The New York Times Company

IN some areas of the United States air pollution is already a greater hazard to agriculture than weather or insect pests, specialists reported at a December 1966 symposium of the American Association for the Advancement of Science in Washington, D. C.

The areas are usually near major cities, but the ill-effects of air pollution have been spreading geographically recently.

In the vicinity of Los Angeles, one specialist said, vegetable farmers have been moving gradually farther and farther from the metropolitan area—into country less favorable to agriculture—partly to avoid the damage inflicted on crops by air pollution.

In California the crop damage by air pollution appears to be more than $100-million a year, said Dr. O. Clifton Taylor, of the University of California.

At a news conference the panel members were asked whether air pollution was becoming a greater hazard to agriculture than that posed by weather and insects. For some specific places, the speakers said, the answer is "yes."

"We have controls for insects at a price," said Dr. Robert H. Daines of the Department of Plant Biology at Rutgers University. "We don't have controls for air pollution at any price."

Farmers in Bergen County, New Jersey, consider air pollution their biggest problem, said Dr. Daines, with leafy crops such as lettuce and spinach especially susceptible.

In the early 1950's only a very few crops were showing damaging effects of air pollution, he said. Now there are at least 40 species and it is "a really growing problem."

Dr. R. Keith Arnold, Dean of the School of Natural Resources at the University of Michigan, said most research on air pollution effects on plants had been limited to study of one or a few species. A subject of great concern that has been little studied, he said, is the effect of air-pollution on whole ecological systems. Research should be expanded to about 10 times its current rate, it was declared.

The effects of air pollution on plants varies greatly from species to species, the speakers said. Wheat and corn seem to be little damaged, while leafy vegetables are extremely sensitive.

Forest trees are also sensitive, said Dr. J. R. Hansbrough of the Forest Service of the U.S. Department of Agriculture.

Air pollutants can damage leaves, kill twigs and small branches, even kill the tree. Pine trees are particularly sensitive to sulphur dioxide from big coal-fired electric power plants.

There is a region extending in a circle with a 20-mile radius around Kingston, Tenn., he said, in which 90 per cent of the white pines have been killed, presumably because of sulphur dioxide and other pollutants from the Tennessee Valley Authority's big power plant in Kingston.

The pines vary greatly in their individual susceptibility to sulphur dioxide and other pollutants. Dr. Hansbrough and his colleagues are grooming pines of varying characteristics to serve as natural indicators of air pollution. Some 600 groups or "clones" of genetically distinct white pines are now being studied.

The hope is to find groups of trees that are each susceptible to one specific pollutant. Much the same attempt is being made with other plant species.

Because plants are more susceptible to air pollutants than mammals are, plants could be used as gauges of air pollution of various kinds. ◆

# AFTER ELMS—WHAT?

## *A final contribution to American horticultural thinking by a distinguished arborist*

**Lowell Kammerer†**

Condensed from the *Bulletin of The Morton Arboretum*, Lisle, Illinois

EVIDENCE of the street-tree-consciousness of the American people in the last hundred years is amply reflected in the March, 1847, issue of *The Horticulturist and Journal of Rural Art and Rural Taste.** In it is reported the organization of The Ornamental Tree Society by the citizens of Northampton, Massachusetts, an association "whose business and pleasure was to turn dusty lanes and bald highways into alleys and avenues of coolness and verdure." Is this not the same goal toward which similar organizations are striving today, and are not modern tree planters confronted by the same vexing problem, "where shall we choose?" At that time the Society set forth this guidepost for governing choice: "Select the finest indigenous trees and shrubs such as the soil and climate of the place will bring to the highest perfection," advice that is still apropos. Among the subjects recommended were elm, sugar maple, the American oaks, locust, tulip tree, white pine and cucumber magnolia.

Another early reference to reliable street trees was a list compiled in the early 1900s by W. A. Murrill of Cornell University. As reprinted in *The Garden*** in 1904, we find the following trees mentioned: Norway maple (*Acer platanoides*), tree-of-heaven (*Ailanthus glandulosa*), sycamore (*Platanus occidentalis*), Oriental plane (*Platanus orientalis*), scarlet oak (*Quercus coccinea*), shingle oak (*Quercus imbricaria*), pin oak (*Quercus palustris*), red oak (*Quercus rubra*) and black oak (*Quercus velutina*). In the same reference further trial was recommended for hackberry (*Celtis occidentalis*), white ash (*Fraxinus americana*), ginkgo (*Ginkgo biloba*) and Kentucky coffee-tree (*Gymnocladus dioicus*).

Having always exemplified everything that was considered desirable in a street tree, it is readily understandable why the American elm attained such popularity, and why finding a satisfactory substitute has presented such a problem. Every aspect of the tree seemed to have fitted it especially for street use. Of stately bearing, with gracefully arching branches uniting overhead in a cathedral-like canopy, it provided beauty without any sacrifice of utilitarianism.

With the perfect street tree still awaiting discovery, replacement must be sought among next-best trees, and the possibilities of the many heretofore untried ones must be explored.

It is now no longer enough just to be known as a "pretty tree," attractive during the blossom or fruiting seasons, in foliage, or in fall color. Size, shape, branch structure, cleanliness, resistance to insect and disease attacks, and to wind and ice damage, tolerance of dust and smoke, and growth rate are of paramount importance. So is ease of transplanting. Furthermore, a good street tree should not impede air circulation, shut out light, or interfere with wires, street lights and other utilities.

Ranking next to elms as favorite street trees, the maples have much to offer. Occurring in a variety of shapes and sizes, there [illegible] be a maple for

†Deceased.

*Vol. 1, pp. 393-397. Edited by Andrew Jackson Downing, 181[illegible]-52, American horticulture and landscape gardener of renown.

**W. A. Murrill, "Shade Trees," *The Garden* (London), LXV (1904), 111, 132-133, 149.

almost any situation. The widely-planted Norway maple (*Acer platanoides*), long a favorite because of its tolerance of urban pollution, has fallen somewhat into disrepute because of its slow growth, heavy shade, and shallow rooting tendencies. However, the Princeton Nurseries of Princeton, New Jersey, have introduced an improved selection, the Summershade Norway maple, which gives every indication of overcoming these difficulties. The uniformity of its oval-pyramidal shape is commendable, its straight trunk and acute-angled branching habit desirable, and its clean green foliage superior. More significant is the tree's accelerated growth rate.

The familiar Schwedler maple (*Acer platanoides schwedleri*) has also made a good showing in our street tree plots, although it is a slow grower. The other form of Norway maple which has distinguished itself here represents an entirely different shape, the narrow-pyramidal. This is the erect Norway maple (*Acer platanoides erectum,* or *ascendens*), a straight-trunked, dark-foliaged tree which by reason of its distinctive contour and restricted proportions is especially usable on narrow streets and parkways.

*From the George James Baetzhold collection, Rutgers University*

**Cucumber magnolia (M. acuminata) is a hardy tree of [illegible] yet graceful shape, with branch[illegible] that always turn upward. Leaves are of exceptional length.**

Another more familiar member of the clan is the red or swamp maple (*Acer rubrum*), an endemic of wide distribution in the eastern half of the United States from Canada to Florida. This good-looking, multiple-interest tree is distinguished by its uniform, pyramidally-oval head, smooth gray branches, bright scarlet pistillate flowers, and red or orange-red fall foliage color. In its native habitat it is a rapid grower, but under typical parkway conditions its rate is considerably retarded. As with the Norway maple, several cultivars have been segregated, one of the most promising being the Scanlon red maple. This compactly branched, conical-headed tree is of medium height (to 35 feet) with a spread of about 16 feet. In uniformity and compactness it is superior to the type.

The familiar sugar or hard maple (*Acer saccharum*), one of our most beautiful shade trees, is another species to be considered. Definitely not an urbanite, it belongs on suburban streets where the air is pure and space ample for its eventual development. Being such a slow grower, crowding is not apt to be a factor for some years. If immediacy is the requirement, there is a fast-growing maple well worthy of acquaintance. A superior strain of the silver or soft maple segregated a number of years ago by an Ohio nurseryman, this selection of better habit has largely overcome the structural weaknesses which have always made the type tree prone to breakage by wind and ice. Of attractive pyramidal shape and a fast grower, it appears to be one answer to the quick shade problem. In catalogs it is listed either as *Acer saccharinum* 'Improved' or *Acer saccharinum pyramidale.* Rather similar in appearance is the little known Miyabe maple (*Acer miyabei*), from Japan, a more compact oval-pyra-

midal tree of pleasing stature and excellent foliage. Its clear golden fall color is something special.

Horse-chestnuts, the pride of European boulevards, do not take kindly to midwestern climatic conditions, but a native counterpart, the Ohio buckeye (*Aesculus glabra*), has, in spite of certain shortcomings, a number of desirable qualifications.

Notwithstanding a natural affinity for moisture, the European alder (*Alnus glutinosa*) shows a remarkable adaptability under cultivation, developing into a medium-sized tree of surprising uniformity. A moderate grower.

If it were not for witches'-broom, a disfiguring abnormality, hackberry (*Celtis occidentalis*), a near-relative of the elm, might well be the answer to the replacement problem. Mature specimens show the same flaring branching habit, fine twiggery, and dense foliage mass of the American elm.

Hawthorns are too broad for most streets, but there are several unconventional species highly qualified for the purpose. The Lavalle thorn (*Crataegus lavallei*) is one, a small (to 25 feet), evenly-rounded tree whose dense, twiggy habit and regularity of form suggest its use on narrow parkways. Exceptionally fine foliage is one of its best features, the persistent leaves being dark toned, of high lustre, and thick texture. Also noteworthy are the tenacious brick-red fruits of good size, which with the bronzing leaves are an outstanding late attraction.

Even more stylized in appearance is the Washington hawthorn (*Crataegus phaenopyrum* or *cordata*), a naturally erect-growing columnar species of diversified interest. Gray twigs, small, lustrous, three-lobed leaves, typical small white blossoms in many-flowered clusters (late May—early June), showy apricot, orange, and scarlet fall foliage color, and handsome Chinese-red fruits are among its attractions. Twenty or twenty-five feet is the Washington hawthorn's maximum height, and its eventual shape is rounded.

Over the years the popularity of the ashes (*Fraxinus*) as street trees has waxed and waned. Being currently in favor, it is well to call attention to two desirable kinds with street-tree potentialities, one imported, the other a native. The Hesse European ash (*Fraxinus excelsior* 'Hessei') is the exotic, a foliage nonconformist with simple rather than compound leaves, dark green in tone, glossy and leathery. Their tenacity gives the tree a prolonged season of effectiveness. It is a slow to moderate grower, eventually attaining 40 feet in height.

The other species, the blue ash (*Fraxinus quadrangulata*), occurs in midwestern upland woods. Indicative of its wide tolerance, however, is the fact that it may also be found in rich, well-drained lowlands.

From Chinese temple gardens to busy city streets has come the ginkgo (*Ginkgo biloba*), prehistoric tree with the reputation of being one of the most dependable subjects for street planting. But in some respects the tree falls short of perfection. Ginkgos are ordinarily extremely variable in shape; moreover, they are not fast growers. Fortunately, several selections have seemingly overcome the shape irregularity. Also important is the availability of staminate (male) trees, the use of which avoids the unpleasant odor associated with fruiting specimens. The foliage is unusual in an attractive way, being fan-shaped, light green in summer and clear yellow in autumn.

Rising from comparative insignificance, the native honey-locust (*Gleditsia triancanthos*) has achieved a new importance since the plight of the elms began. Having a flaring branch structure somewhat like that of the American elm, and supporting a canopy of fine-textured foliage, it seems a logical substitute. The tree is not entirely faultless, however, inheriting the weak-wooded characteristic typical of most fast growing trees. Borers sometimes present a problem, too, and other pests such as pod gall and mimosa webworm have shown up. Their presence may be significant, however, in serving as a warning against the folly of overplanting a single species. The rediscovery of the honey-locust has led to the appear-

ance of a number of new cultivars, all improvements over the type. The Moraine locust (*Gleditsia triacanthos* 'Moraine'), the first of these, a thornless, podless form of pleasing vase shape and good growth, was introduced by the Siebenthaler Nurseries around 1947. Later came such desirables as 'Imperial' and 'Skyline', patented introductions of the Cole Nursery, and Princeton Nurseries' 'Shademaster.'

To find the Kentucky coffee-tree (*Gymnocladus dioicus*) on a list of recommended street trees may be a surprise, particularly to those who have known it as a slow-growing native of rather uncouth appearance. Closer appraisal is necessary to reveal its true worth. Under forest

*Edward H. Scanlon & Associates*

**Scanlon red maple (above) is compact in its branching habit. Lavalle thorn (left) will seldom interfere with overhead wires.**

conditions it sends up a tall, straight shaft crowned by a narrow head, but specimens grown in the open more often divide into several flaring branches upholding a rather rounded foliage canopy not unlike that of the American elm. The leaves are doubly compound and of luxuriant appearance, yet giving filtered shade. Leaflets show an interesting color sequence in their seasonal change from pinkish-bronze (when unfolding) to medium green (summer) and finally gold (autumn). The ultimate average height of the tree is about 50 feet.

The cucumber-tree (*Magnolia acuminata*), hardiest of the native arborescent magnolias and the tallest growing (50-80 feet), is occasionally encountered as a

lawn specimen, but seldom if ever along streets. This has always seemed unfortunate for a subject so impressive in its symmetry of form and boldness of foliage. In blossom this magnolia is disappointing, but the contorted cucumber-like fruit with red-coated seeds make up for the lack of floral showiness. So does the coarse-textured foliage. Individual leaves, while usually 7 or 8 inches in length, may reach 16, an exotic size for the North. Under cultivation it is classed as a moderate grower.

Although a slender-branched tree of the forest understory, the ironwood or hop-hornbeam (*Ostrya virginiana*), when grown in the open develops into a surprisingly neat, round-headed specimen 30 to 50 feet tall. With thin, often persistent leaves suggestive of birch, inflated bladder-like fruit arranged in cone-like clusters, staminate catkins grouped in threes, and yellow fall foliage color, there is never a time when it lacks interest.

Where but in botanical collections may one become acquainted with the cork-trees (*Phellodendron*), that lesser known group of Asiatics noted for their hardiness, ability to thrive in dry soil, tolerance of city adversities, and comparative immunity to pests? The short-trunked round-headed Amur cork tree (*Phellodendron amurense*) is a favorite here, its splendid glossy compound foliage presenting a handsome dark summer aspect, and assuming delightful clear lemon-yellow fall tones.

To most people oaks and slow growth are synonymous, a reputation which has limited the use of one of our finest groups of shade trees. Some species, like the white, bur and scarlet, are very slow, to be sure, but there are others which will keep apace with the closest rivals. The northern red oak (*Quercus rubra,* or *borealis maxima*) is one of these. Tall (to 75 feet) and straight, with massive, acute-angled branches, it is an imposing subject with excellent clean foliage and orange-yellow fall color. Admittedly it does not transplant as easily as some trees, and is susceptible to borer damage, but if moving is delayed until late April and the trunks are carefully wrapped after planting, the sun scald which paves the way for borer entry may be largely avoided. Similar wrapping is advised for all smooth-barked trees. Another shapely, lesser-known species whose pyramidal-oval outline and deflected lower branches resemble those of pin oak, is the shingle oak (*Quercus imbricaria*), exotic-appearing native whose elongated, unlobed leaves suggest magnolia. The formal pyramidal outline and downward sweeping branches of the pin oak (*Quercus palustris*) are better known, and for a good-looking, fast-growing, easily transplanted parkway tree there is much in its favor. Its susceptibility to chlorosis, a yellowing of the foliage resulting from an iron deficiency, or rather nonavailability, is its only serious fault, but this condition can be controlled.

No group of street or lawn trees is more deserving of being called magnificent than the lindens (*Tilia*), widely distributed genus of ornamentals known for their regimented silhouette and regular branching. Splendid avenue trees so much a part of the European scene, they could be similarly employed here if their foliage were not host to so many insects, so sensitive to dust and soot, and if borers were not so attracted to their smooth trunks.

Knowing that some will question the omission of favorite trees from any list of recommendations, a few brief explanations may be necessary. For example, flowering crabapples have not been included because of the litter their fallen fruit creates; birches have been by-passed because of their susceptibility to borer damage; and the rapid-growing sycamore (*Platanus occidentalis*), because of anthracnose, a foliage-disfiguring disease to which it is subject. Sycamores also have the reputation of being untidy, as their tendency to drop foliage in hot weather, strips of bark, and later seed clusters creates quite a nuisance. The fast-growing bitternut hickory (*Carya cordiformis*) has been omitted because its long tap root complicates transplanting, and the highly ornamental sweet-gum (*Liquidambar styraciflua*) and tulip-tree (*Liriodendron tulipifera*) are not included by reason of their often unreliable hardiness this far north. ◆

# 50 YEARS A "FLOWER GIRL" IN KENSINGTON

Joan Rodker

Reprinted from *The Times*, London, England, October 3, 1966

MRS. SHAKESPEARE—"no relation, darling"—this year celebrates 50 years of flower-selling in Kensington plus roughly a dozen more in Paddington where her mother and father both had stalls and where she got her first experience selling buttonholes at a penny and twopence each before morning school. "Nearly everyone wore buttonholes in those days . . . my dad used to cut a potato across and stick it full of holes and make a lovely fan shape of roses."

Today Ada Shakespeare has arthritis and spends most of her time in the cushioned chair beside her flowers. When ill-health keeps her at home, her corner patch of pavement at the roaring junction of Church and High Streets looks grey and desolate. "I love everybody," she affirms, "you give love and you get love back. And for the naughty ones I pray."

One of 11 children (six surviving), with two "flower-girl" sisters working not far away, Mrs. Shakespeare has lived all her life in Kensington. She has a son who carries on her late husband's removal business, a daughter, and three grandchildren.

She also has Charlie, who sweeps and carries for her and sometimes serves. Charlie, who is 54, has been with her since he was 16 "and his mum was with me 40 years. He was a pageboy at the Victoria Club but when he got older they wanted someone younger."

Mrs. Shakespeare dwells on many things with fervour. Her lovely family, flowers (freesias are her favourites "for the perfume of them, the fragrance"), the kindnesses of royal patrons and the second career she and her husband built up as artistes, performing in pubs, clubs and workhouses all over London.

*Joan Rodker*

Mrs. Ada Shakespeare with her helper, Charlie, at her flower stall in London.

"He had a lovely tenor voice, my husband. I'd work a few numbers and give him a rest. Lovely tap dancer, he was, too."

Of course, Mrs. Shakespeare has her worries—"who hasn't, darling?" There is her arthritis, the traffic "getting noisier all the time" and rising costs. But whether she is reminiscing about the "good old days" when she drove around in her pony cart knowing just what flowers her ladies wanted to match their rooms, or admiring today's mini-skirted "lovely new class of customer," Mrs. Shakespeare has few regrets. As a local character, there aren't many like her any more. ✦

# "UGLIFICATION IS AGGRAVATION"

Virginia S. Eifert†

Condensed from *The Living Museum*, The Illinois State Museum, Springfield, Illinois, March 1966

'"I NEVER heard of 'Uglification', Alice ventured to say. "What is it?"

'The Gryphon lifted both its paws in surprise. "Never heard of uglifying!" it exclaimed. "You know what to beautify is, I suppose?"

' "Yes," said Alice doubtfully: "it means —to—make—anything prettier."

' "Well, then," the Gryphon went on, "if you don't know what to uglify is, you *are* a simpleton." '

It would seem, from a glance about our big cities and along many American rivers, roads and woods, that some of us have learned more about uglification than beautification. But uglification, as any Lewis Carroll character might have suggested, is aggravation, especially when we are the ones who have to look at it and live with it.

It is not the way of wild creatures to defile their own nests. There even are certain birds which bring pretty shells, leaves, and other trinkets to adorn their abodes. The wild creatures have never had to live with ugliness, except that which man has wrought in a once pure and pristine landscape.

With an awareness now heightened all the more by the President's war on this defilement of our landscape and Congressional bills now doing something about it, we are even more aware of the state of some of our surroundings. Of course, there is still much beauty. There are still cool mountain brooks purling ice-water over stones, still fragrant forests and woodlands full of flowers; there are free-flowing rivers whose waters are clear and clean, and lake shores which are unlittered by beer cans and bottles. In contrast, then, the stark ugliness which has been perpetrated upon us inflicts shock and disgust. It is an affront to the senses, an insult to the innate love for the beautiful which seems to be part of all men until they somehow forget and let it be lost.

One day in April not so long ago, as a southbound train was leaving Chicago and passing through the usual shambles of slums and trash and unsavory dumps and mangled autos, an unforgettable vision suddenly presented itself. Over these miles of offensive landscape it was still spring, still April, and April would not be denied. In the midst of oil-soaked ground and piled-up oil drums, broken rubbish and no particle of greenery, a single, lovely, golden, unutterably magnificent forsythia bush was in full bloom. Who can say how it got there, how it managed to blossom so beautifully among its foul surroundings, or how many people its brief vision refreshed? A single candle of beauty, it stood in the midst of human ugliness, a proof that no landscape is devoid of hope.

It is not only places like this but the rivers and lakes which also have suffered blight. For a long time the majority of river fronts became a repository for old motor cars, bedsprings, broken glass, reeking rubble, rats, and tin cans. It was easy to dump unwanted objects over the rim of the bank and let the river carry it all away—usually to deposit it on some other shore. Thus shores were defiled, rudders fouled, water polluted, fish poisoned, people endangered, and eye and nose offended. River clean-up campaigns are, however, creating miracles of rejuvenation; strict laws against pollution are having effect.

For America is noted for possessing a conscience. Although that conscience may take a while to stir, it usually awakens before it is everlastingly too late. In the past we could perhaps be excused for our tardy awakening because of that old notion of the endlessness of American land.

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* Deceased, June 16, 1966.

*Virginia S. Eifert*

Beauty of a river—the upper Mississippi

With so gloriously much of everything, it was natural for man, coming from an often pinched and deprived Europe, to be prodigally wasteful. If the land was ruined by overgrazing or by poorly rotated crops, by erosion, by trash dumps and industrial desecration, it was easy to move on to new land rather than to handle properly the old. There was so much space. When forests were all cut off, men and saws were moved to the next tract of virgin timber westward, then "cut out and get out," on and on to the Mississippi River and beyond, until they ran out of forests. If a million wild pigeons were slaughtered in a season, it was confidently expected that there would be plenty more for the next year's shooting. The illusion of limitless natural wealth was easy to come by in a land as lovely and large as ours.

The sobering realization that forests do not in fact go on forever, that it is possible for a race of wild things to become extinct, that rich land may be ruined, that rivers may become sterile, ugly, gray, oozing messes contaminated by human carelessness, that mountains of mangled motor cars fill once-lovely meadows, all has come as a growing shock. We are not really like this, we protest, not really so bad; we did not mean to mistreat this land which we love . . . it just happened when we weren't noticing. It has been a humbling experience to realize that only we ourselves are to blame for defiling our own landscape, and that no one but we may effect the rejuvenation.

For nature is resilient. It is endlessly resurrected, is seldom totally ruined, except for the lost wild things which cannot ever be reborn. Now that the national conscience has been awakened, one day American uglification will have become a bad dream of the past.

According to the Gryphon, anyone who doesn't know what uglifying is must be truly a simpleton. Because Americans are not simpletons, we are now spending billions of dollars in a great national movement to remedy our mistakes and turn ugliness into beauty. The lone forsythia bush in the oil dump may one day be surrounded by hundreds of its kind. ◆

# CURES FOR VIRUS DISEASES

## *Heat treatment dominates methods for restoring plants with certain virus ailments to full health and vigor*

**Francis O. Holmes**

MANY plants and animals are victims of virus diseases. The search for cures is a constant concern of scientific investigators, and there have been many encouraging discoveries that are not generally known. Among both ornamental plants and economic crops, the application of precise degrees of heat thus far leads other curative methods. But additional types of treatment are also being developed.

One of the primary problems in freeing plants from viruses has been to recognize the presence of the virus.

During the early years of the twentieth century horticulturists noticed that many varieties of plants that had been propagated by rooted cuttings (or by grafting) showed decreased growth vigor over a period of time. The reason for this supposed growth decline with age became a much discussed botanical mystery.

Eventually it was shown that most if not all of the observed "age degeneration" was due to low-virulence viruses; these inconspicuous but persistent viruses damaged their hosts, but did not kill. This largely dispelled the mystery. In sharp contrast: plants that had become infected by viruses of *high virulence* had long since been eliminated. They either could not compete with neighboring healthy plants, or had been discarded by disappointed growers. On the other hand, stocks that had been infected by viruses of low virulence had usually been planted again and again in succeeding years.

Actually, the plants with low-virulence virus diseases grew almost as well as healthy ones, but not quite so vigorously. The gradual decline in their vigor as they accumulated more and more of these nearly symptomless infections was what had been mistaken for the effects of simple old age.

### Early Attempts at Cures

The prevalent opinion at the time was that plants could never recover from virus diseases. Agricultural scientists, however, were aroused to action. Plant disease specialists searched remote farms and gardens, wherever they thought that healthy plants of an infected variety might exist. They realized that except in rare cases not all plants of a variety would have become infected at the same time. Insects that carried a virus from one plant to another (or other vectors such as mites, nematodes, or *Olpidium* fungi that are now known to act also as vectors of viruses) would often infect scattered plants within a crop, leaving neighboring plants entirely virus-free.

Whenever a healthy plant was found, it was carefully protected and grown for propagation at a distance from diseased plants of its own kind. Sometimes the healthy plantings were maintained in cool northern climates or at high elevations where spread of viruses had been found to be relatively infrequent. For example, northern-grown lots of virus-free "seed" potatoes were sent south yearly for large-scale production of "table stock."

In some cases the search for healthy stocks failed. Certain potato varieties were found always to carry the so-called X virus. The beautiful Wedgwood iris has never yet been found in what must have been its original healthy state, without iris mosaic virus. Every commercially-grown horseradish plant seemed to contain a virus that is commonly called turnip mosaic virus. It is a curious fact that most, if not all, viruses that affect plants can live in a number of different plant hosts; the names chosen to designate them often indicate only the first host in which they were noted and they may be found

*Jerry T. Walker*

Tobacco leaf with spots that show infection with ringspot virus, transmitted from leaves of American ash.

more often in other host plants, as is true in this case of turnip mosaic virus.

## First Signs of Success

Hopes for eliminating the chronic virus diseases that caused "age degeneration" began to rise. If cures could be accomplished at will, instead of being found only in chance virus-free plants, many old varieties could be restored to the pristine health of their pre-virus years by freeing them from their chronic viral diseases.

A chance discovery showed how substantial progress could be made. As early as 1889, the importance of sereh disease (a severe stunting of sugar cane) had been recognized and attempts had been made to cure it by treating seedpieces with hot water. Temperatures as high as 50 degrees Centigrade (122°F.) and periods of exposure up to one hour had been tried, but without success. Then Wilbrink, in Java, unintentionally cured sereh disease in 1923. Some plant disease specialists at that time believed that "bacterial gummosis" of sugar cane and sereh disease were different manifestations of the same malady. Wilbrink suspected that they were not, and he tried to differentiate between the two by killing the gummosis bacteria by heat and leaving the sereh disease unchanged. Instead, his hot water treatments produced sereh-free plants. Sugar cane affected by sereh disease alone was cured in some instances by treatment for 30 minutes at 52 to 55 degrees Centigrade and most consistently in 30 minutes at 45 degrees followed by 30 minutes at 50 to 52 degrees Centigrade. Had the original investigators raised their temperatures slightly—two or three degrees—sereh disease might have been cured a third of a century earlier!

Subsequently, in 1933, Martin in Hawaii and Bell in Australia cured chlorotic streak disease in sugar cane by a 20-minute treatment at 52 degrees Centigrade (126° F.). This procedure was used later for tons of sugar cane seedpieces, which were enclosed in great nets and dipped in tanks of hot water for the required 20 minutes. At the end of this time, they were lifted again and dipped into tanks of cold water. The method proved highly successful and was dependable under conditions in the cane fields. Virus-free cane yielded substantially more sugar than affected cane.

Much later an affliction of sugar cane

Horticultural varieties of such plants as strawberries, potatoes, and fruit trees are believed to be potentially immortal. At least, we have no evidence that they ever die of old age as varieties, although many individuals of each variety may succumb. An old apple tree may become so decrepit from advanced age that it will topple over and die without so much as a strong wind to hasten its downfall, but its young shoots may be saved if they are cut off promptly and grafted onto an appropriate seedling rootstock.

Once a notably useful seedling of a vegetatively propagated plant is selected as a new variety, it is no longer propagated by seed but by the use of vegetative parts, such as runners, tubers, or grafted buds. The original seedling represented by each horticultural variety is thus kept alive more or less indefinitely.

called "ratoon stunting disease" was cured by 2-hour exposures at a slightly lower temperature, 50 degrees Centigrade. This disease, although difficult to diagnose by casual inspection, retards growth and seriously reduces yields of sugar.

## Hot Water for Peaches

In the United States, Kunkel showed in 1936 that budwood of peach could be freed from peach yellows virus even by brief hot-water treatments. The time required for cure at 46 degrees Centigrade was 15 minutes; at 56 degrees Centigrade (133 F.) it was a mere 15 seconds. The curative treatments ensured that propagating material could be freed from all strains of peach yellows virus before being grafted onto seedling understocks. The same investigator cured peach rosette disease by exposure of affected budwood at 50 degrees Centigrade for eight minutes. Other American investigators had success in curing two additional peach diseases, respectively known as phony disease and yellow-red virosis; in each case they used hot-water treatments of short duration.

During the first half of the twentieth century only a few more than a dozen virus diseases were proved curable, mostly by brief exposures to heat. These successes had set the stage, though, for further developments.

## New Approach in England

Kassanis at the Rothamsted Experimental Station in England showed in 1950 that destruction of virus by heat was not always necessary—or even possible—without killing the host plant at the same time! He found it sufficient to keep plants just warm enough to prevent virus reproduction in the tissues. By this means, exposing affected potato tubers to a temperature of 37.5 degrees Centigrade for 25 days, the potato leaf-roll disease could be cured. In the following decade many other diseases were found curable by similar treatments.

Numerous successes followed moderate temperature treatments of strawberry diseases. Stocks of strawberry plants suffering from single or mixed virus diseases, of the kinds called mottle, crinkle, mild crinkle, yellow edge, and mild yellow edge, were made healthy again. Growers of the old and chronically sick stocks hardly recognized the same varieties when they were returned to them as healthy plants. They had literally been given *new plants for old.* The healthy stocks of strawberry had larger, greener leaves, grew with more vigor, and easily outyielded the old "degenerate" stocks that had once been the best available.

## Defoliation Technique

The predecessor of the successful heat treatments had been the process of defoliation to cure a virus disease, but so far this has worked with only one plant. This process was successful in the flowering-maple (*Abutilon striatum thompsoni*) whose variegated foliage is a result of virus infection. Baur in Germany noted that shaded and defoliated plants of this variegated *Abutilon* grew new leaves that were almost free of disease spots. Removal of these still infected leaves then often effected a permanent cure.

## Minute Cuttings from Healthy Tips

A third type of treatment was eventually added to the repertoire of plant virologists. This was cure by excision of healthy parts of diseased plants and propagation from these isolated portions.

Viruses tend to spread rather erratically within their host plants. The plants are often stunted for a time after they are infected by a virus, but growth usually begins again soon and may proceed at nearly a normal rate. The invading virus in most cases spreads slowly throughout the plant as new tissues are formed by growth of branch and root tips. Substantial amounts of healthy tissue may therefore exist even in affected plants.

Some viruses follow the growth of developing stems and branches more or less regularly, but not at all closely, lagging behind by an inch or more. For example, dahlia plants infected by spotted-wilt virus remain infected from year to year.

*Craig R. Hibben*

**Partially infected plant of *Vinca rosea*, the tall side-shoot not yet troubled by the yellows virus that has stunted the rest of the plant. Flowers on the side-shoot are the normal pink; on the stunted portion they are dwarfed and white.**

Cuttings rooted for propagation usually carry the disease. Yet the rooting of very short tip-cuttings has been shown in most cases to exclude the virus. This means that the virus does not follow the growing point so closely as to be included in stem tips that are just long enough to be rooted. A slight modification of nursery practice can thus greatly reduce the percentage of this disease in plants grown from rooted cuttings.

Some other viruses follow the growing tips of their host plants more closely, yet leave an uninvaded portion that may be an eighth of an inch or so in length. Aspermy virus in chrysanthemums is never lost when tip cuttings of the customary size are rooted. Yet shorter bits of the growing tips can be shown not to have received the virus. They are too short to be rooted directly, but they can be grafted onto healthy varieties of chrysanthemums and grown there until they have become long enough to be cut away and rooted independently. From a single healthy plant, obtained in this way, thousands of stock plants can be propagated in a few years. While aspermy virus does not produce conspicuous symptoms on chrysanthemum plants, when aphids carry the virus from chrysanthemums to tomato plants the tomato crop is reduced almost to zero; hence the interest in curing chrysanthemum stocks.

Some viruses follow the growth of their host plant very closely, for example, dahlia mosaic. All attempts to root or graft tip-cuttings have failed to produce virus-free plants. So the French workers Morel and Martin, in 1952, excised very small portions of tissue from branch tips. These they cultured on nutrient media until they were large enough for independent growth. By this procedure old varieties of dahlia, once uniformly infected by dahlia mosaic virus, can be established again as healthy stocks. More recently single-cell cultures of some virus diseased plants have been grown into whole plants, many of them uninfected.

## Other Types of Cures

Success has also lately been attained in eliminating some viruses from diseased stocks of bulbous plants. Bulbs often carry several different viruses (simultaneously) and some of these diseases may not become apparent unless a certain combination of viruses is present. Propagation through bulb scales of Easter lilies and cormules of gladioli have resulted in plants that were free from viruses affecting the parents. These discoveries were made by Brierley of the U.S. Department of Agriculture.

Recent years have brought a few reports of success by chemotherapy to add to the list of cures by other methods.

Some infected plants can be cured by storing them at temperatures that are too

(*Concluded on page* 54)

# ORNAMENTAL MOSSES HAVE LANDSCAPE POTENTIAL

## *The Japanese know how to use them*

**Elizabeth Pullar**

Reprinted from *The New York Times*, March 20, 1966. © 1966 by The New York Times Company

MOSS is perhaps the most neglected plant in American gardens. If it appears at random, it is likely to be raked away or dug out as a weed, for its presence is thought by many as a sign of poor, acid or over-moist soil. Actually, moss is a versatile, ornamental plant. Gardeners need only take note of how moss is esteemed and employed in Japanese gardens to appreciate its potential in home gardens.

### How Mosses are Used in Japan

In sharp contrast to Western gardens with their shrubs, lawns and profusion of flowers, the Japanese garden is characteristically bare. This reflects a belief of Zen Buddhism that true beauty is nothingness. The atmosphere of Japanese gardens is meant to induce meditation, contemplation and peace.

In Kyoto, the ancient cultural city of Japan, some very old gardens are still in existence. Those at the Saiho-ji temple were designed by Musokokushi, who lived in the 14th century and is considered one of Japan's most illustrious landscape artists. Part of his work is the Kokedera or Moss Garden, where close to 100 varieties of this miniature plant may be seen carpeting the ground.

### Attractive as Groundcovers

Adaptations of the Japanese use of moss can be made in American gardens. For example, moss may be set out as groundcover here as well as in Japan. There, it is planted to cover bare soil under shrubs in gardens where shrubs are the only living growth. In this country the shrubs are usually concentrated where soil is vulnerable to weeds. Mosses placed in the spaces between shrubs will spread to form their characteristic cushions and are a surprisingly pleasant change from the usual pachysandra or vinca groundcover.

The growth of mosses is particularly attractive beneath rhododendrons. Since the roots of rhododendrons are shallow, soil should not be disturbed by cultivation and a carpet of moss is an ideal cover to enhance the surface under the evergreens. By using a variety of moss species, an interesting pattern of diverse color and texture can be achieved.

### In Rock and Wild-Flower Gardens

The Japanese cultivate mosses on many of the rocks which adorn almost all of their gardens. In American rock gardens, too, mosses can be a decorative addition. In a native garden, moss can be a charming foil for ferns and wild flowers. With the Japanese garden as an inspiration, a woodland setting becomes an appropriate locale to experiment with growing different varieties and types of mosses. Some are extremely short while others will approach 4 or 5 inches in height. Most mosses are bright green, especially after a rain. Other kinds appear brown, red, light green or even yellow. Lichens, although interesting and attractive, are gray and not true mosses.

# FUTURE FOREIGN TOURS SPONSORED BY THE BROOKLYN BOTANIC GARDEN

The Botanic Garden Tour of Japan and Southeast Asia in the autumn of 1966 brought such an enthusiastic response from participants (see page 2 of this issue) that three further study tours are being sponsored for 1967 and 1968. One will be a return visit to Japan, Taiwan, Hong Kong and Thailand, another will include parts of Portugal, Spain and Morocco, and the third will be to South Africa—last stand of the great wild animals of the earth, and homeland of the famous "Proteas"—wild flowers indigenous to the Cape Peninsula. The maps (turn page) show the travel routes for two of the trips, and it is planned that each tour will be of approximately three weeks duration. Come with us to see many places off the usual tourist routes. All tours will be led by one or more Botanic Garden Staff Members who either know the areas well or have toured them at least once previously. Experienced native language guides and first class hotels throughout.

**Portugal, Spain and Northwest Africa (Morocco)**

**March 1968**

This trip will include en route a two-day stopover in Lisbon, on the River Tagus, to see its famous gardens and surrounding countryside. From there the group will journey by motorcoach to such places as Seville thence to Gibraltar and Tangier. In Morocco the tour will include the three capitals—Rabat, Marrakech and Fes, also Meknes, parts of the Atlas Mountain region, and the fringe of the Sahara. Returning to Madrid via Granada (Palace and gardens of the last of the Moorish kings, etc.), the tour will concentrate on Madrid, Toledo and other nearby points of special interest.

**South Africa. September 1967 (or 1968)**

***(preference of dates to be indicated when writing in)***

Early autumn in the U.S.A. is springtime in South Africa, and is the best season to see the most floriferous peninsula in the world (the Cape Peninsula). It is also a good season to see South Africa's wild life—preserved in national parks for more than a half century. Virtually all the big game for which Africa is famous can be seen on this tour. Thoughtful Americans will also be interested in the "separate development" of peoples, as practiced in South Africa.

# November 1967 or April 1968
## (*indicate year preference*)

Return trip to Japan, with optional extended tour to Taiwan, Hong Kong, and Thailand. See page 2 for a general outline of the earlier tour. Many people want to see Japan in the spring, and will wish to visit places other than those included in the earlier trip. In so far as possible, the itinerary will be arranged according to the special interests of those who indicate their desire to go to Japan either for the first time—or on a return visit.

---

If you wish to indicate a preliminary interest in any of the tours outlined here, please fill out the following, and return prior to June 1st.

Each tour participant must be a member of the Brooklyn Botanic Garden for at least six months previous to departure.

(tear off)

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# BROOKLYN BOTANIC GARDEN MEMBER TOURS

**— Preliminary inquiry —**

Name .....

Address .....

Probable number of people in your party .....

JAPAN. Year preference ☐ 1967 ☐ 1968

☐ Send further information

SOUTH AFRICA. Year preference ☐ 1967 ☐ 1968

☐ Send further information

PORTUGAL, SPAIN and NORTHWEST AFRICA. March 1968

☐ Send further information

**(return this sheet to Office of the Director, Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn. N. Y. 11225)**

## The Botany of Mosses

Botanically, mosses are the least highly evolved of the green land plants. They have no roots or flowers, only stems and leaves. In place of roots, they emit tiny rhizoids which anchor the plant to the ground but do not absorb food. Mosses obtain water and nutrients from the air through the surface of their stems and leaves. Reproduction is by spores borne in great numbers in capsules.

## Collecting and Transplanting

The very best source for gathering mosses is a rich woodland. Here a great number of varieties will be at home on the ground, rocks, decayed logs and fallen trees. After a heavy rain mosses look their best and are easy to dig. Since most grow in clump formation in soil, it takes only a trowel to loosen a mat and lift it into a basket. Enough original soil clings to the specimen to allow it to adjust to a new environment. A knife blade is useful to scrape moss off a rock or tree.

Most moss adjusts readily to a new location. It thrives in a moist but not water-logged soil and responds to shade, especially from April to September when the sun is strong. To prepare soil to accommodate moss, a light activating with a scratcher is all that is necessary. Then thoroughly wet the soil and both the top and underside of the tuft of moss. Press it gently into the loosened soil and it will soon send out new rhizoids for anchorage.

The appearance of moss varies with the weather. During the hot, dry summer months, many mosses will turn crisp and brown only to become completely rejuvenated at the first drop of rain. In cold weather, through half-melted snow, moss becomes a radiant green and is a bonus to the winter garden. ◆

*Elizabeth Scholtz*

Moss garden of the Saihoji Temple in Japan. The entire ground beneath the trees is carpeted with moss.

# CHRISTMAS TREES BEING GROWN ON UTILITY RIGHTS OF WAY

*Acreage beneath transmission lines is rented out for a profitable crop*

**Mitchell Gordon**

Reprinted from *The Wall Street Journal*, December 8, 1966. © 1966 by Dow Jones & Company, Inc.

STEPHEN WAGNER, 12, cannot tell a lie. He cut down the Christmas tree.

It was a handsome tree, growing just off the Santa Ana Freeway in the shadow of a 10-story bank building near downtown Los Angeles. Stephen did the deed with his trusty, 14-inch pruning saw. Was he punished? Hardly; his father, his mother and his two little brothers watched the whole operation approvingly.

Stephen doesn't come from a family of lawbreakers. The Wagners, like thousands of other Southern Californians, were benefiting from a utility's efforts to cut costs by leasing land under its 220,000-volt electric lines. The land is used for tree farms, which not only bring in money but also improve the appearance of the rights of way in keeping with Mrs. Lyndon Johnson's national beautification program.

One of the many successful commercial plantings of Christmas trees beneath the power lines of the Southern California Edison Company.

The utility, Southern California Edison Co., is one of several that are putting acreage under transmission lines to productive uses. Florida Power & Light Co., for another, long has leased such land for grazing and farming, among other purposes.

But the growing of Christmas trees is a recent development and seems sure to spread. Holyoke Water Power Co. of Holyoke, Mass., also recently planted 67,000 trees on about 70 acres of its rights of way. In a few years, when the trees mature, Holyoke will make them available free to local Boy Scout groups, which will be responsible for replanting.

Southern California Edison decided in 1962 to make its rights of way available for a small fee to growers of Christmas trees, and the first of the trees are just now getting tall enough to sell in quantity. As sales have picked up, so has interest among prospective tenants.

"Right now we have 22 tenants growing some 180,000 trees on about 98 acres of rights of way, mostly in Los Angeles and Orange County," says Wesley A. Hubbard, the utility's senior rights of way agent. At present, Mr. Hubbard is negotiating leases with five other growers for 57 acres capable of accommodating more than 100,000 trees.

The leasing arrangement has proved highly popular with growers. The utility's longest tenant, 46-year-old Jack Hughes, is a former carpenter who turned to growing Christmas trees during a slowdown in home building. The husky Mr. Hughes had gotten his exposure to the Christmas tree business several years earlier by making wooden tree stands as a sideline.

Mr. Hughes expects to sell 8,000 to 10,000 trees this year, double the number he sold from his initial crop last Christmas. He expects to average $5 a tree at his new base price of $1 a foot; last year he sold the few trees he had over six feet tall for a flat $6 and smaller ones for $4.50. His business has been so successful that last July he added 16 acres to the 20 he already had under lease.

Mr. Hughes' wife and son-in-law assist him year 'round, and he has hired a dozen others for the Christmas season to help him sell trees. He finds most of his customers, like young Stephen Wagner, prefer to choose and cut their own trees, and they are given pruning saws for that purpose when they enter the premises.

"By cutting their own," he says, "our customers know they have a fresh tree that won't drop needles all over the floor." This appeal appears to be strong enough to overcome the slightly higher prices Mr. Hughes charges over conventionally merchandised trees.

There are some problems in growing Christmas trees in an urban environment, particularly in Southern California. One early tenant tried to grow the wrong kind of tree and went out of business when they all died. "We have no natural enemies here but a bad smog attack can brown the needles of a couple of hundred trees at a time," Mr. Hughes says. He adds that it takes 18 months or longer for damaged needles to turn green again.

Mr. Hughes also has to pay more for his lease than he would if he were growing trees in a more rural setting. He pays Southern California Edison $200 an acre annually, compared with a cost of only about $5 an acre to lease land in some parts of the Pacific Northwest, but transportation to Southern California is a costly problem there. And Mr. Hughes' leasing cost is still much less than he could obtain elsewhere in the Los Angeles area.

There also is a 15-foot limit on the trees so they won't pose any danger to the overhead transmission lines. But Mr. Hughes doesn't count that as any problem. He expects to sell his trees long before they reach that height. ◆

## PORTABLE GREENHOUSE

A GREENHOUSE that can be easily transported along with household furniture has been devised by the Reverend Paul E. Holland of Eaton, Colorado, who describes the structure in the *Bulletin* of the American Orchid Society for July 1966.

Measuring 12 by 4 feet and sloping from 4 to 3 feet, back to front, the small greenhouse is covered with Mylar (extremely durable) and lined with a less expensive grade of clear plastic. The front is hinged, and front and sides are bolted together for easy disassembling. The top is of three removable panels.

Heating is done with a thermostatically controlled electric heater with a fan. Total cost was about $50. ◆

# IN A MEXICAN GARDEN

## *Lessons learned by a New Englander show how to make northern gardens gayer and gardening easier*

**Dwight Hutchison**

Condensed and reprinted by permission of *Woman's Day* magazine.
© 1966 by Fawcett Publications, Inc.

EACH year through four winter months I live in a garden in Mexico. When April comes to New England and the daffodils I planted in the fall are thrusting through the ground, I come back to Connecticut.

It might seem disheartening to leave the rich midsummer flowering of Mexico and start all over with seeds and seedlings in the still-frosty New England earth. But to many gardeners the beginning of a garden gives more pleasure than the final flowering; the anticipation is more exhilarating than the fulfillment. Mexico is well behind me when I get out the garden catalogues, make my lists and prepare my flats.

And yet Mexico is not totally forgotten. My garden here is not the garden it would be if I had not gardened there. Lessons learned in those walled-in, sunny gardens I can use in my northern garden.

We must first acknowledge the differences, which are many. In most of Mexico there is no frost. This means that non-hardy plants like geraniums, begonias, fuchsias may be left out right through the year to grow larger and larger with dozens of blossoms where we would have five or six. An ivy geranium may cover an entire side of a house; fuchsias hang from a balcony, each one as large as a bush.

Such mild temperatures also mean that one may live outdoors right through the year, and so naturally more attention is paid to terraces, patios, little courts and enclosed gardens.

The immediate thought when I return is how the Mexicans love privacy and how indifferent we are to it. The first time I walked through the town where I live in the winter I thought what a stony, bare town it was. No trees, except in the parks; no gardens. Then I went up to the hotel roof and looked across the town. There were probably more trees than in my home town in Connecticut, but the trees and gardens were all behind walls. They were in the private domain of each house. There inside his walls, in complete privacy, the Mexican eats, naps, entertains his friends, plays with his children. Coming back to the United States one is almost shocked at the open lawns and gardens, the houses so blatantly exposed, the lack of seclusion.

Thus my first lesson learned is the pleasure of a private corner, shut off from the street and from the neighbors. Not a porch but a garden corner. It can be small enough for only a table and four or five chairs. It can be shut off by a hedge, a fence or a wall.

Grass is not satisfactory for the floor of this outdoor living room. Furniture must be moved when the grass is cut, it is not usable after rains or early in the morning, and the chair legs sink into the soft ground. Instead, try flagstones laid in sand or cement; hard-packed sterile earth covered with white pebbles, crushed marble or stone; or perhaps even have a floor of cement. This will be more attractive if marked off in squares or diamonds. In Mexico patterns are made with small pebbles, pushed into the cement while it is wet.

Perhaps an even more important lesson I have learned in Mexico is the use of flower pots in a small garden. The Mexican places them on walls, on steps,

*Drawn by Eva Melady from a photograph by Allan W. Kahn*

around the edge of a border, on window sills and on balustrades. They line paths; they are massed in corners. Sometimes they are hung on fences or walls, suspended from the overhang of a balcony or placed along the edge of roofs.

Such a garden is easily cared for. The pots may be moved about to give each plant its share of sun, or the plant in full flower may be given the best position. Of course geraniums lead as potted plants, but any annual may be used: petunias, marguerites, marigolds, zinnias. For hanging pots: ivy geranium, begonia, fuchsia, tradescantia. Pots on a balustrade or a roof must be securely anchored. The flower pots may be massed for a border effect or they may be evenly spaced, the pots themselves adding to the decorative effect.

In many backyards there is a waste space by the garage, perhaps once a clothesyard. Do not think it is too small for a Mexican patio; if properly planned the size is not important. But it will take courage, for first you must dig up worn-out shrubs, remove the grass and topsoil and pave the area. You may want to paint the garage wall a soft Spanish pink or light green. You may want to put a fence on the property line or plant a hedge to separate this garden from the rest of the yard. Stand your potted plants against the garage wall, or make a planting box along it, or a narrow raised bed.

Also try hanging flower pots on this wall, or on a fence, in holders. A simple pot holder may be made of a wire coat hanger.

There is one caution about using potted plants, especially hanging plants. They must be watered more frequently than plants growing in the earth. To keep down evaporation glazed pots may be used. Clay pots may be painted with a transparent varnish, or the pots may be lined with a thin sheet of plastic.

In my small patio in Mexico there is a wild orange tree in the center. In this country it could be a flowering crab, a

FLOWER-POT HOLDER MADE FROM COAT HANGER

dwarf fruit, a dogwood. An arbor and a seat in your patio with a well-disciplined vine shading it might be a pleasant addition.

It is impossible to describe Mexican gardens without mentioning water. Against the rear wall of my patio there is a fountain of blue and yellow tiles. The water spouts from a faun's head in the rear. Such a fountain would not be practical here, but having enjoyed the sound of water and the fluttering of the birds coming for a drink, I make a New England substitute.

I have run a hose, hidden behind plants and buried slightly, from a double outdoor faucet to a shady corner. Here I have a large brass bowl sunk in the border, surrounded with mossy stones, with ferns and forget-me-nots and primroses and mint. The nozzle of the hose is buried in the rocks and the water dribbles down drop by drop. I turn this on only on special occasions, but even without the water running it is a pleasant spot and brings the birds to my yard.

If you make this garden as small as a room, you will find the work is easy: no weeding, no digging, no grass-cutting or trimming. You snip the dead flowers and water, you sweep or rake your floor. You rearrange your pots and move your chairs from sun to shade. Mexicans are said to be lazy. Perhaps we should learn from them how to have a delightful garden and be lazy too. ◆

# TURF OVER CONCRETE

*Scott Seeds*

"By far the best-looking lawn on the street" is the consensus two years after having been laid on a concrete base. As a lawn-building experiment in Marysville, Ohio, headquarters of O. M. Scott & Sons, turf specialists, the ground in front of this new house was completely covered with concrete, as shown below. Strips of Windsor sod were laid directly over the concrete, watered every day or two in summer and fertilized five times a year. The lawn is highly successful.

# ILLUMINATED INDOOR GARDEN

## *Development of fluorescent lights makes it possible to grow decorative plants even in dark halls*

**Henry M. Cathey**

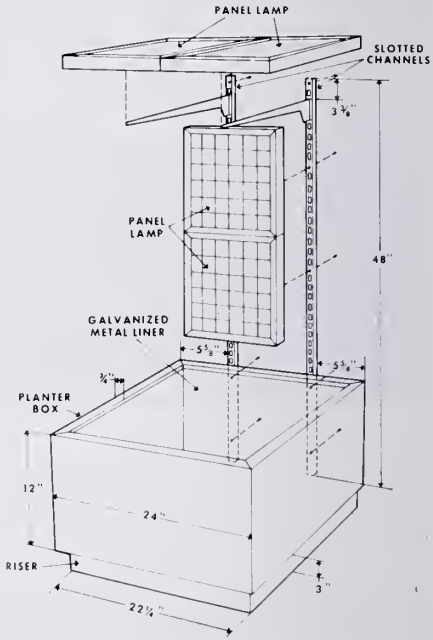
Condensed from the bulletin "Indoor Garden for Decorative Plants" of the U. S. Department of Agriculture

YOU can grow and display many kinds of decorative plants in your home by using an indoor garden which is essentially a planter equipped with high-intensity fluorescent lights. With the development of high-output (HO) panel fluorescent lights and very high output (VHO) fluorescent tubes, many of the handicaps formerly encountered in trying to grow house plants have been overcome.

When grown in an indoor garden illuminated by these HO and VHO fluorescent lights, plants thrive—plants that barely existed indoors before the lights were developed.

To grow plants satisfactorily in an indoor garden—

- Water the plants only enough to prevent wilting— then water thoroughly.
- Fertilize the plants every 2 to 4 weeks while they are actively growing.
- Illuminate the plants with HO or VHO fluorescent lights 12 to 16 hours daily.




An indoor planting such as this, equipped with lights, can be easily made at home.

### Planter Box

The planter box can be made of fir plywood painted to match the walls in the room where it will be used, or it can be made of veneered plywood stained or oiled to match the furniture that it is to be displayed with.

Inside the planter is a watertight liner. This liner is best made of sheet tin painted with asphalt to retard rusting. For a temporary liner, heavy-gauge polyethylene may be stapled inside the planter.

The planter is mounted on a platform equipped with castors, that fits under the riser. The garden may be moved easily; floors and carpets around it may be cleaned and plants in the garden may be reached easily for care and replacement.

### Lighting System

The lighting system for the garden using panel fluorescent lights consists of separate lamps, ballast, fixture, and timer.

The panel fluorescent lamps may be General Electric deluxe cool white (FP—

123/CW).[1] They also are available in tints other than cool white. They require special connectors [ALF 510 series], which should be ordered at the same time the lights are ordered.

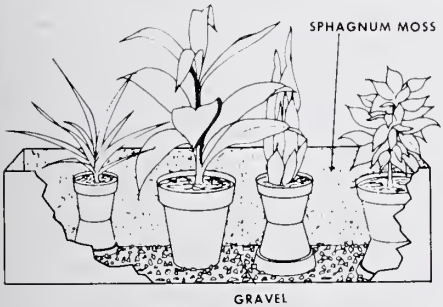
Rapid start ballast 7G3720 is required for these lamps. One ballast will operate two panel fluorescent lamps.

When you order lamps, ask the dealer if fixtures are available for them. If not, you will have to make your own or have them made. The fixture consists of a wood frame about 13 inches square. Three of the sides of the frame have grooves cut in the inside faces. The panel fluorescent lamp is slid into these grooves and the fourth side of the frame then is screwed in place, holding the lamp secure in the frame.

## Locating the Setup

The best place to put an indoor garden is where the temperature during the day is about 75° and during the night about 65°. Avoid locations near heating ducts, exhaust fans, or doorways to the outside. Hot air from heating ducts heats and dries the plants. Cold air and drafts from exhaust fans and outside doors may chill the plants.

Wherever it is used, an indoor garden will light the ceiling and walls as well as the plants. This extra light may be welcome; it may serve as the primary source of illumination for the room. But it may be unwelcome—glare, rather than brightness. To reduce glare, put fiberglass diffusers on the backs of the panel lamps. *Do not put diffusers between the lights and the plants;* the plants need all the light they can get.




Pots should all be made to stand at the same level.

## Selecting Plants

Select plants according to the amount of light you are prepared to supply. In general:

- Foliage plants need only be lighted from the top.
- Flowering plants must be lighted from the top and back of the indoor garden.

## Potting and Placing the Plants

All plants that go into the indoor garden should be in clay pots. Bagged potting soil, available in most garden shops and in many hardware stores and large grocery stores, is satisfactory. Or you can mix your own potting soil from equal parts of (a) garden soil; (b) sand or perlite, and (c) peat moss. Add one tablespoon of rock phosphate and one tablespoon of limestone to each gallon of soil mixture. Before using the soil, mix it thoroughly, adding water until the soil mixture is crumbly moist.

Though the panel fluorescent lamps used in the garden are not as hot as incandescent lamps, they generate enough heat to harm plants that come in direct contact with them. Therefore, keep all plants at least 4 inches away from the panel lamps.

## Fertilizing

Every two to four weeks, water the plants in your garden with a solution of water-soluble fertilizer used at the concentration recommended on the label. Fertilize only when plants are actively growing. ◆

[1] Trade names are used in the publication solely to provide specific information. Mention of a trade name does not constitute a guarantee of the product by the U.S. Department of Agriculture nor does it imply an endorsement by the Department over comparable products that are not named.

# HOW TO BUILD A BOG GARDEN

## *A naturally wet site in sun is most satisfactory; meeting plants' requirements is important*

**Charles O. Masters**

Condensed from *The Garden Journal,* The New York Botanical Garden, September-October 1966

BY definition, the bog garden serves as a place for the cultivation of plants which normally inhabit only the wet or soggy soils of marshy areas. It should be so developed that it is natural in appearance, distinctively attractive, and fits well into the surroundings.

Completely artificial bog gardens, although it is possible to create them, are not nearly so satisfactory as those which have been adapted from suitable natural features. The fact that the site is a low-lying one, on which rain and snow water settle during much of the year, is not sufficient reason to consider it as a potential marsh. A great deal of ingenuity would be required to convert such a situation into a bog garden, since excavating and sealing with clay or cement would have to be done. It is much more desirable to work with the margin of a pond, the bank of a flowing brook, or a gushing spring, any one of which would assure a constant and adequate supply of water. A waterlily pool, already located on the property, can also be used to furnish boglike conditions.

The requirements of the plants should be foremost in mind throughout the planning, construction, and maintenance of the bog garden. Bog plants will sometimes live in soil which is not wet, and some will even adapt themselves to life under water, but it is advisable to duplicate the conditions of their natural habitats as closely as possible.

Whatever the size of the area, it must be wet and poorly drained so that it will retain moisture, and most, if not all of the site should be in full sunshine. Where shade is necessary, it can be obtained by placing tall plants in strategic locations.

*Charles O. Masters*

**Marsh buttercup *(Ranunculus septentrionalis)* is one of the attractive flowers worthy of cultivation in a bog garden.**

Low-growing plants should be used only along the southern side.

Marsh plants make an effective background setting along the boggy shoreline of a waterlily pond. The composition of the entire garden can be built around this portion. If you are so fortunate as to have a brook or small stream flowing through your property, the wet area along the bank can be cleared and transformed into a beautiful show the year around by the use of moisture-loving plants.

It must be emphasized again that from the very beginning the bog garden must be properly prepared. Clay or cement can be used in relatively small areas to hold water and keep the soil moist. But remember—marsh plants are accustomed

to wet feet, but not to swimming! The soil must be rich and acid (pH 4.5 - 5.5), containing a goodly amount of decayed humus and fiber. (If necessary, such soil can be brought to the proposed bog-garden site.) Natural bog soil is ideal, so if you have a marshy area, much of your work is done. Some gardeners will insist that the richness and the acidity of the soil are more important to the well-being of the plants than is moisture, and that the condition of the soil might be the keynote of success. Soil acidity may be retained by the occasional addition of decaying leaves, and topdressing of sawdust or peat moss. Cultivation of the soil is definitely not recommended, even if it were practical.

After the basic requirements for the bog garden have been met, consideration must be given to the selection of plants that are at home only in marshlands. And while it is altogether possible to "go overboard" and choose a goodly number of unusual species—because they are certainly available—it is advisable to confine your initial selection to those which will readily adapt themselves to the existing conditions. You can, of eourse, acquire additional speeies from time to time.

It is important to arrange the plants so that there will be no clashes in color and no eneroaehment on one species by another. Good use can be made of foliage plants to break the lines between the species which bear bright flowers. The plants should be set in clumps with no attempt at integration, the patches of bare soil between the different clumps soon filling in.

Plantings from the deep areas to the shorelines should be completed, keeping in mind the special requirements of each species, and then the bank and background plantings should be arranged to emphasize a harmonious effect.

Mass plantings of the cat-tail (*Typha latifolia*) are best suited to the water-line of a lily pond where it comes close to the background slope. Only a clump or two should be included in the entire area, since the cat-tail tends to spread rapidly.

Certainly the marshy outline should not extend around the entire pond nor along the entire bank of a flowing brook. Sections should be characteristically free from conspicuous vegetation. Mosses and liverworts serve well to cover the line where water and soil meet.

Ferns are happy in a bog garden—some with water near their roots, others away from the shoreline in drier soil, still others among the rocks along the bank of a brook. Requirements of the particular species, such as cinnamon, interrupted and royal ferns (*Osmunda cinnamomea, O. claytoniana, O. regalis*), American maiden-hair fern (*Adiantum pedatum*), ostrichfern (*Pteretis pensylvanica*), marginal shield fern (*Dryopteris marginalis*), hay-scented fern (*Dennstaedtia punctilobula*) and so on, should be carefully determined before they are planted.

A higher background, besides being an artistic part of a bog garden's composition, provides protection from stormy weather and destructive winds. Sturdy shrubs and trees should be kept on the northern and eastern limits. Hardy herbaceous plants are also useful there.

A number of nurseries list plants for bog gardens, but now and then it is possible to collect these plants, *with permission*, from existing marshlands.

A well-made bog garden can eventually become a cool, green oasis to which one can retreat on dry, hot summer days when the usual garden chores seem burdensome. ◆

**Broad-leaved arrowhead *(Sagittaria latifolia)* with three-petaled white flowers, is common in marshy areas throughout North America.**

*Charles O. Masters*

# GARDENS IN JAPAN

## *A philosophical dimension new to the West*

George S. Avery

Reprinted from *The Garden Journal*, The New York Botanical Garden, November-December 1966

IT can hardly be said that a wave of popular interest in Japanese gardens is sweeping across America. What can be said is that since World War II, Japanese gardens have once again come to the attention of our western world and are attracting considerable interest.

Students of the garden arts, amateur and professional alike, are discovering in Japanese gardens a new dimension, one which is likely to have a deep influence on the future of American gardens. It is a philosophical dimension, which awaits discovery by those who seek something other than masses of color and continuous bloom in their gardens, something other than formal design and extensive collections of exotic plants. The "something other" is surprisingly simple—nature itself in its own inviting asymmetry.

As interest in Japanese gardens has grown, many gardeners have bought stone lanterns, perhaps small busts of the Buddha, and a small stone pagoda or two—and placed them in their gardens. The objects may indeed be of Japanese origin, but no one should labor under the delusion that their presence alone makes a Japanese garden.

For those who would fully appreciate—or construct—a Japanese garden, there are three key words, a mastery of which will pave the way to understanding. These are *esthetics, finesse,* and *restraint.* The first has to do with the science of the principles of art—the SCIENCE OF THE BEAUTIFUL; the second with DELICACY OF EXECUTION, SUBTLETY OF DISCRIMINATION, REFINEMENT, and the third with CONTROL, CONTAINMENT, MODESTY, TRANQUILITY. Once these meanings are imbedded in one's thoughts, the beauty and simplicity of the Japanese gardens will be understood. The rocks, water, hills and plants of the natural landscape were the essence of Japanese gardens a thousand years ago. They are no less so today.

The oldest garden in Japan which is recorded in the literature was that of Sogano Umako. Yoshinaga tells us that nearly 1,350 years ago, Umako built his new house on the Asuka River in Yamato Province, Nara Prefecture. It was surrounded by a garden with a small pond and island. Within a century of Umako's time, other gardens were constructed—with hills and ponds, with skillfully arranged rocks symbolizing the scenic beauty of the seashore. Such were the beginnings of naturalistic gardening in Japan.

A moment of digression is in order here, for Richardson Wright has given us a brief and superb sketch of historical events in Japan which led to the flowering of Japanese culture—of which gardens were such an important part. It was the introduction of Buddhism to Japan in about the fifth century A.D., and the broad sweep of Chinese culture which accompanied it, that also brought gardens. The Zen sect of Buddhism, a philosophy of East Indian origin, reached Japan during the magnificent Kamakura Period (1186-1335), and it was during this time and two centuries or so which followed that garden art flourished, along with landscape painting, flower painting and arranging, sand pictures (bonseki), and the *Noh* drama. The Tea Ceremony

**The Brooklyn Botanic Garden's Japanese hill-and-pond garden, showing an island with a snow-viewing lantern and a drum bridge to the "mainland." In the distance is a Torii, or "Gateway to Heaven."**

was developed by priests of the Zen sect during this period. Richardson Wright comments that the Tea Ceremony grew into a national sacrament devoted to "the admiration of the beautiful in the sordid facts of everyday life." He further observed that it became an essential factor in splendid old feudal Japan and even today stands as a national symbol which patriotic Japanese evoke to offset the disintegrating influences of Western customs. Around its ritual grew up a code of ideals which in turn affected both garden design and the enjoyment of gardens—a true feeling for nature.

Of the three historically most important types of Japanese gardens, the *hill-and-pond gardens* are both the oldest and most widely appreciated. They are gardens which typify the varied natural landscapes of Japan, but in condensed and simplified form. To convey the feeling of great space within a limited space is one of their secrets, but nature remains their basic subject matter. The art of perspective, carried out in part by using the pruning art to keep even old trees small, made a garden landscape appear larger than it actually was. But there also had to be special qualities in the heart and mind of the viewer to give a garden deeper meaning.

"Reverence for nature," writes Takuma Tono, "is one of the outstanding racial traits of the Japanese people, and guidance by nature's revelation provides a way of life in which nature is both important and precious to all Japanese." He goes on to say that the fundamental aim of landscape gardening in Japan rests primarily upon *viewing, instructing,* and *consoling*—"gardens are intended to break the connection with the outside world, so to speak, and to produce a fresh sensation conducive to full enjoyment of estheticism in nature."

Thus, one philosophical concept of an ideal Japanese garden is that it should be a retreat for leisure hours of contemplation and meditation. Within it there should be the added dimension of living symbolism, a language all its own; for example,

**Replica of the Ryoanji Temple stone garden at the Brooklyn Botanic Garden. "How lovely the ungreen garden!" was a comment by *Life* magazine.**

the pine tree is a symbol to the Japanese of long life, while the plum blossom suggests courage, and the bamboo perseverance. Artificial features usually added to hill-and-pond gardens, as well as other types, include stone ornaments such as lanterns and water basins. But the essential elements of such a garden are its "skeleton" of stones—chosen for their intrinsic beauty and symbolism, its hill or hills, its pond and in-flowing stream, its island, paths, and stepping stones, garden gates and bridges, clipped hedges, and its studied positioning (and continued pruning and shaping) of individual trees and shrubs. Finally, the whole is enclosed by the customary high fence.

Lawns were unknown in the earlier gardens; mosses or just hard clay made up the flat expanses.

Flowers, *per se*, are of lesser importance in traditional Japanese gardens, not that the Japanese do not love flowers —they do; but they use them with restraint in creating garden landscapes. Flowers are ephemeral elements in a garden, while evergreen trees and shrubs make a continuing contribution to the strength of the landscape throughout the year. A green garden symbolizes long life. Thus such Japanese gardens are essentially monochrome, and if this is not understood in advance, it can be disappointing to foreign visitors in Japan. Professor Tono tells of conducting a group of Americans to some of their more important gardens. After the first day of the tour, one lady inquired . . . "but when are we going to start seeing gardens?" She apparently was disappointed not to find a blaze of color and symmetrical design.

A second historically important type of garden—the *flat garden,* apparently had its beginnings at least five hundred years ago. Conder tells us that "the same tranquil and prosperous times which helped so much to advance the sister arts of poetry and calligraphy, and which first stimu-

lated the cultivation of the tea ceremonial, also brought patronage to the art of the landscape gardener." It was a period of the popularization of landscape gardening. Buddhist priests, masters of the Tea Ceremony and purveyors of culture generally, were the great garden designers; temple grounds afforded space for their practice. And thanks to them, it is chiefly around the temples of Japan that the classical gardens have been preserved. Centuries old, many have been designated as National Treasures. Best known of the flat gardens is the stone garden of the Ryoanji Temple (Temple of the Tranquil Dragon) in Kyoto. The original temple was burned to the ground during one of Japan's many civil wars, but after being reconstructed toward the end of the fifteenth century, a Stone Garden was built by its side—to be viewed from a veranda wing of the Temple.

The Ryoanji garden is an abstract garden composition and has no plants other than little tufts of moss which grow around the stones. About the size of a modern tennis court, and closed in on three sides by a low, roofed wall, its level area is a bed of what appears to be coarse sand, skillfully ripple-raked to suggest the sea. Seen from the viewing wing of the Temple, its key points "for contemplation and meditation," are fifteen stones—in five groups; no two stones and no two groups are alike. To compare the garden of Ryoanji with traditional gardens of the West is like comparing an abstract painting with traditional art. They are simply different.

There are other flat gardens of historic significance, but Ryoanji remains the masterpiece. Its symbolism has been variously interpreted. One view is that it represents a limitless sea with islands rising in it. A modern-day author regards it "a sermon in stone which speaks to man of his intimate relationship with nature." Whatever interpretation may be given the Ryoanji garden, its beauty and meaning are in the eye of the viewer. He will take away with him whatever he has put into it. A distinguished American architect speaks thus of Ryoanji . . . "it is deceptively simple in design, but this is what gives it power. I have never seen anything to match it in perfection of scale."

Those who long for plants in a Japanese style flat garden may have them. There are many such in Japan. One of the most revered is the Moss Temple Garden (Saihoji, also in Kyoto) where,

Another view of the Brooklyn Botanic Garden's hill-and-pond garden, showing the cascade, the pool, and numerous dwarfed trees.

except for trees and occasional shrubs, the only plants are mosses. It is a woodland garden of subtle moods, depending upon the weather. To view it in the rain is an unforgettable experience. Modern "hybrids" between the gardens of Ryoanji and Saihoji are to be found in other temple gardens in Kyoto, and at the Tenman Shrine, Dazaifumachi, on the Island of Kyushu.

The third historically important type of Japanese garden is small and intimate, the *Tea Ceremony garden.* It must convey the feeling of simplicity and seclusion and is especially designed to foster the meditative spirit. It, too, is a flat garden, enclosed with a tight, high-above-eye-level fence. A small tea house is attached. Stepping stones, low-growing shrubs, a rustic lantern, water basin, and a tree or two complete the picture. Professor Tono points out that as guests for a Tea Ceremony "pass slowly from one stepping stone to another, with the garden scrupulously clean and watered beforehand," they "cannot remain indifferent or unsusceptible to the beauty of nature, enhanced by the art of the landscape gardener."

Many contemporary gardens in Japan are simply variations of those described and illustrated here. Some are inspired by another classical type of garden, which features "dried-up water scenery." These were first designed by Zen priests and date back at least five hundred years in Japanese history. They feature simulated water courses strewn with sand, pebbles, and boulders—and often lakes. While always without water, they convey the feeling that water was once there or will again bubble over the sand and pebbled course. This exercise in imagination is one of the fundamental concepts in Zen thought.

Whether a Japanese garden is of one type or another, if situated where a distant view of mountain, forest, or sea can be brought into the composition, as a backdrop, this enhances the feeling of space and beauty. "Borrowed scenery" is the phrase for it.

What conclusions can we of the West draw from this brief account of Japanese gardens? It seems fair to say that our woodland gardens are in the same spirit as most Japanese gardens which feature the natural landscape. We have simply failed to gain the philosophical dimension. And without this, how could we hope to have our gardens mirror nature, and reduce them to human scale? Our national reverence for mountain and valley, forest and grassy plain, desert and stream is growing—in terms of understanding the importance of space and conservation of the wild—but most of our people are insensitive to the spiritual riches nature offers. It is here that I think naturalistic Japanese gardens will have their greatest impact on the gardening art in American life. And as for the abstract gardens, such as Ryoanji—with growing interest and at least partial acceptance and understanding of abstract art in America, we no longer find these gardens quite so exotic and alien. Zen priests in their hours of meditation (and sometimes creative thought) gave Japan such gardens five centuries ago. Contemporary Zen scholars hold that many such gardens represent the best in abstract art. They can be utilitarian, but also have important philosophical dimensions. They offer a worthy challenge to garden thinking and planning in the West. Whatever our personal opinions, it is important—collectively—to keep our gardening minds open to treasured cultural developments from all over the world ✦

## FOR FURTHER READING


Conder, Josiah: Landscape Gardening in Japan. Dover Publications, Inc. New York. 1964. (Originally published in 1893; second edition, revised, in 1912.)

Tono, Takuma: A Secret of Japanese Gardens. Tokyo, Japan. 1958.

Wright, Richardson: The Story of Gardening. Dover Publications, Inc. New York. 1963. (Originally published in 1934.)

Yashiroda, Kan (ed.): Dwarfed Potted Trees; the Bonsai of Japan. Brooklyn Botanic Garden Handbook #13 (*Plants & Gardens,* Vol. 9, No. 3. 10th printing. 1966.)

Yoshinaga, Yoshinobu. Japanese Garden Art. (*manuscript*)

# TAKING STOCK OF NEW RURAL PROPERTY

*Investigation of topography, physical features and soils is recommended before land development begins*

**Lawrence S. Hamilton**

Condensed from *The Conservationist,* New York State Department of Conservation, June-July 1966

HAVE you acquired a piece of rural property in which to put down roots, to escape the asphalt jungle, to serve as a week-end retreat, or to develop as a country year-round home, to retire to?

No matter what your motivations may be, you will eventually want to do something to enhance the value of your land and the flora and fauna which it is providing.

Before changing or re-arranging landscape components to achieve your general goals, it would seem prudent to take inventory of the natural resources of your domain. It may be that your general goals will become somewhat modified, or focused into specific goals, by virtue of the material you find you have to work with. The property may contain a gravel deposit of considerable value, a rare plant which merits preservation, a good spring to be protected and developed, or a topographic situation suitable for a pond.

Taking stock is not simply a matter of naming the resources or counting them, but involves the matter of location. Where are they on the property? How do they relate to one another? A number of kinds of maps and photographs are useful in such stock-taking.

## Topographic Maps

The standard U.S. Geological Survey topographic map is useful. It does not supply specific information about what is on your particular property, but it does relate it topographically to surrounding country, and physically to nearby roads, villages, cities, water bodies and other physical features of your locality.

The maps are printed in at least three colors—blue, black and brown. Most of the maps published since 1951 show wooded areas in green, and in ordering maps you should specify whether or not you wish the woodland coverage.

These maps are available from the U.S. Geological Survey, Washington, D. C. 20025 for areas east of the Mississippi River and from the same agency at the Federal Center, Denver, Colorado 80225, for areas west of the Mississippi. They cost approximately 30 cents per sheet, and may be obtained by indicating the township and county where your property is located.

## Aerial Photographs

One of the most valuable stock-taking aids is the aerial photograph. All of the United States has been photographed at least once. The most recent pictures, of course, give you the best idea of what resources currently stock your property, but if you are interested in the changes which have taken place on your land, you may wish to avail yourself of earlier photography as well.

The standard vertical aerial photograph print is 10 by 10 inches and covers an area approximately 3.2 by 3.2 miles. A single photo, therefore, is usually large enough to cover all but very large land holdings. The scale of these photos is approximately 1,660 feet to the inch. Cost per photo in single prints or small quantities is about $1. One good source of photographs is the United States Depart-

ment of Agriculture. If located east of the Mississippi, send to the Eastern Laboratory, Aerial Photography Division, Agricultural Stabilization and Conservation Service, U.S.D.A., 45 South French Broad Avenue, Asheville, North Carolina 28801.

West of the Mississippi, send to the Western Laboratory of the same agency, at 2505 Parley's Way, Salt Lake City, Utah 84109. To obtain the photograph of your property, mark its location accurately and clearly on a road map, and send map, money and size of picture desired.

What can be obtained from the aerial photograph? A trained interpreter can tell much about present and past land use, types and relative depth of soil, bedrock, kinds of vegetation and so forth. Even a novice may gather useful information. From a single photograph of recent vintage, you may often determine property boundaries, also interior boundaries which divide your property up into sub-units which may be useful development or management units. The photo shows the nature and shape of forest land, cultivated fields and pasture. Streams are shown and any ponds or lakes. Structures, roads and well-used trails are visible (even deer trails). The relation of land-use pattern on your property to surrounding properties is revealed better from the air than from the ground.

## From the Ground Down—Soils

The characteristics of the soil resource beneath your feet largely determine the kind, amount and quality of the living components of the landscape, both plant and animal. For instance, woodchucks do not inhabit soils of poor drainage, and neither sweet corn nor tulip-trees will grow well in soils of low fertility. Moreover, certain kinds of soils are more suitable than others for many man-made uses such as ponds, septic tank disposal fields and roads. A knowledge of the characteristics of the various soils on your property is therefore an important part of stock-taking, for it provides what might be called a "basic capability" map.

Fortunately, in most areas, soils maps are available at low cost. The Soil Conservation Service of the U.S. Department of Agriculture, in co-operation with the State Agricultural Experiment Stations, conducts soil surveys and publishes the results, usually on a county basis.

Your local county Agricultural Extension Service or Soil Conservation Service can advise you of what soils information is available for your county. In addition to a map, there is text material describing each of the soil types mapped and some interpretation for possible uses of these soils.

Once you have located your property on these maps, you will probably find that it includes several soil types. Each of these types is described in the text in terms of such properties as depth, texture, color, stoniness, drainage, slope, acidity and parent material. These properties will be of considerable importance to you if you are planning to alter the existing use of the land. Particularly is this true if you plan to plant new vegetation such as Christmas trees, wildlife food plants or landscaping plants, or to engage in such activities as impounding water for a pond or building some structure on the property.

Conversely, if you have in mind some particular form of land use, for example planting Douglas fir for Christmas trees, the county soil map would indicate suitable locations where one might buy property. One would have to have some knowledge of course, about the soil requirements of that species in order to select appropriate combinations of soil properties. Other factors, such as presence of brush, size of suitable area, ease of removing products, etc., might finally narrow your choice to one or a few areas. (Aerial photographs are helpful in this process.)

Moreover, if you are obtaining land management advice from a consultant or a public agency, the existence of a soils map of your property will greatly expedite their work. If you are going to work from the ground up, it would be prudent to look from the ground down. Soils are basic to land use planning. ✦

# APPLE-GROWING FENCE

## *Within four years a sizable crop can be harvested from an ornamental property divider*

**Howard A. Rollins, Jr.**

Reprinted from *Home Garden*, February 1966

DWARF apply trees, trained to a wire trellis, can be developed into a screen or boundary marker that will give great satisfaction. Besides their practical use as a fence, they make an attractive ornamental display and provide a seasonal supply of crisp, juicy apples. They can be used even in a very small area.

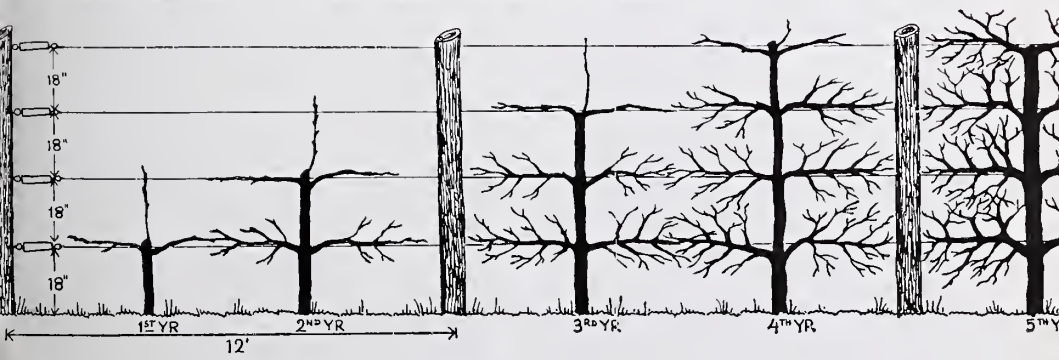
There are many ways that an apple fence can be developed and modified to satisfy varying situations. In my own yard I was looking for some way to screen the garden area from the children's play area. An apple fence about 90 feet long including a 6-foot archway in the center provided the solution. The following procedure worked well for me. You may find that slight modifications would satisfy your needs better.

The first step is to build the trellis by setting posts about 12 feet apart with about 6 feet of post extending out of the ground. I used 8-foot treated posts for most of the fence and 10-foot posts at the ends. The next step is to string wires between the posts at heights of 18, 36, 54 and 72 inches above the ground. Large screw eyes can be used in the end posts with small holes drilled in the center posts at the correct heights.

The wires should not sag, but neither should they be too taut. It is also a good plan to have a turnbuckle at one end of each wire to take up any slack. You may wish to brace the end posts, but I have not found this necessary since the wires don't support much weight. Their main function is to serve as a trellis to which apple branches can be tied.

You will need two trees for each 12-foot section of fence. They should be spaced about 6 feet apart in the row. Apple trees consist of at least two parts—the scion variety and the rootstock. There are a number of rootstocks available that will restrict the ultimate size of the tree. Malling IX, Malling VII and Malling Merton 106 are three such rootstocks and all are appropriate for use in an apple fence. Some nurseries and garden centers may merely refer to such trees as dwarf apple trees of either this or that variety.

**Posts set 12 feet apart with four wires strung a foot and a half apart form the basis for the growing of espaliered apples as a fence.**



The selection of varieties depends on personal preference. One practical system would be to use a number of different varieties ripening over a long period of time to provide a continuing supply of ripe fruit from midsummer to late fall. Such a sequence of varieties might include 'Lodi', 'Williams Early Red', 'Jonathan', 'McIntosh', 'Red Delicious', 'Golden Delicious', 'Rome' and 'Stayman'. In more northern areas, 'Rome' and 'Stayman' may not ripen adequately.

If your fence is primarily for ornamental purposes, alternating sections of 'Red Delicious' and 'Golden Delicious can create a handsome effect. But regardless of your selection, be sure to buy one-year-old "whips" of the largest diameter possible. These will give you the opportunity to develop the main branches where you want them.

Early spring (before growth starts) is the best time to plant deciduous trees, and apples are no exception to this rule. Dig a hole large enough to allow the roots to spread out. Then plant each tree the same depth as it was in the nursery row. This can be determined by a close examination of the trunk. Fill the hole with fertile topsoil, pressing the soil firmly around the roots. When the hole is approximately two-thirds filled, water the tree thoroughly and allow the soil to settle. Then finish filling the hole, leaving a slight depression around the base of the tree. This will aid in holding moisture when the trees are watered during the first year or two.

After planting, cut each whip back to the point where it crosses the lowest wire. As soon as growth starts in the spring, at least three buds will usually develop within 3 to 5 inches of the place where cuts were made. The uppermost of these new shoots is allowed to grow upright to form a central leader. The next two branches are maintained for training along the first wire. All other new growth is removed. Once the two lateral shoots have grown 8 to 10 inches, they are tied down to the wire nearly horizontally.

The second spring, the central leader is cut off at the point where it crosses the second wire, and the procedure described above is repeated. During the summer it may be necessary to do some additional pruning. This will consist largely of removing branches that develop in undesirable places.

In heading back shoots along the lateral branches, it is best not to remove them completely but merely to head them back by two or three buds. The same technique is then repeated in the third and fourth years until all of the wires are supporting lateral branches. From then on it is mostly a matter of removing growth that may develop in the wrong places. A mistake often made in the training of apple fence trees is the failure to prune enough. Just remember that the correct shape of each tree must be maintained if an attractive appearance is to be preserved.

The amount of fertilizer needed to maintain an apple fence will depend upon tree response. A good rule of thumb would be to apply ½ pound of 10-10-10 per foot of fence in a 4-foot band extending 2 feet on either side of the fence. If a fertilizer of a different analysis is used, adjust rates in order to apply the same amount of actual nitrogen.

If trees make too much vegetative growth and leaves are dark green, cut back on the amount of fertilizer applied. On the other hand, if trees are making little or no growth and leaves are pale with a yellow cast, then increase the fertilizer, particularly nitrogen.

An apple fence should be sprayed to maintain control over the various insects and diseases that typically affect apples. One of the principal advantages of growing apples in this fashion is that it is very simple to spray and care for them in general since all parts of the trees are within easy reach. Any of the all-purpose fruit sprays should be satisfactory.

While an apple fence is attractive and intriguing, it will also yield a significant volume of fruit. Some trees in our fence produced over 70 apples the fourth year.

An added bonus derived from our fence has been stimulated interest in plants by the children. They continually visit the fence, and their excitement at seeing blossoms transformed to small apples and finally mature fruit is ample reward. ◆

# ORGANIZING FOR CONSERVATION

## *How a community can initiate action*

**John I. Green**

Reprinted from *The New York State Conservationist*, Department of Conservation, February-March 1966

START a local Conservation Committee with representatives from schools, Scouts, Kiwanis, Rotary and other interested major civic organizations.

List all natural resources and resource problems in and around the community.

Plan for action!

Here are some suggested action programs:

I. **Be Alert for Beauty Areas**—Spots in or near community worth preservation—a secluded glen, a waterfall, a stand of hemlock near enough for a visit by schools, nature groups and Sunday strollers. The Nature Conservancy, 2039 K Street, N.W., Washington, D.C. 20036, can provide help for planning and acquisition.

II. **Make an Arboretum in Your Park for Beauty and for Educational Use**—The 4-H, Girl Scouts, Campfire Girls—all have tree identification projects. Use native tree species at first. To help in planning use "Recipe for Tree Planting," a State College of Forestry publication, Extension Dept., Bray Hall, Syracuse University, Syracuse, New York.

III. **Beat the Heat**—Campaign for better planning for shopping plazas and downtown commercial areas. Bright, vivid, desert-like conditions are typical of our new villages. They need trees; shade for beauty and comfort. Plan to plant on Arbor Day (a different day in spring in different states).

IV. **A Town or County Picnic Area**—Plan to include a well-stocked farm pond for family fishing fun. It might be what your community is missing. To start on farm ponds, consult your County Agricultural Extension Agent.

V. **Community or School Forest**—Keep watershed areas under forest management. For this, cooperate with your State Conservation Department and join their Forest Practice Act program. Reforest a few acres with conifers and hardwoods for school use. Call your District Forestry office listed under your State Conservation Department.

VI. **Conservation Education Day**—Help plan a local Conservation Day for all fifth or sixth grade children. Contact the County 4-H Club Agent for a planning outline. Select a good farm with soil conservation practices. Let your State Conservation Department foresters and game biologists help you plan. Add a Federal Soil Conservation Service man to your committee.

VII. **Conservation Education Workshop**—Plan it for either elementary or secondary teachers. Plan on telling what, and why, and include *how* to teach conservation by inviting conservation education extension specialists from the New York State College of Agriculture at Cornell* and from the College of Forestry, Syracuse University.* Your County 4-H Agent can also help you with this.

VIII. **Teaching Resource Pool**—List people who are willing to help teach Scouts, teachers, and 4-H'ers, in these and other subjects:

(a) Tree identification.
(b) Making bird feeders and houses.
(c) Bird study.
(d) Wood lot management.
(e) Stream biology.
(f) Wild flowers.
(g) Astronomy.
(h) Fish and game laws.
(i) Conservation legislation.
(j) Hunting safety training course (for obtaining license).
(k) Wildlife identification.
(l) Outdoor cooking and how to prepare and cook game.

IX. **Conservation Night**—Provide a monthly series of lectures for the winter months. Select outstanding films for spe-

cial community programs. Ask Conservation Foundation, 30 E. 40th Street, New York, N. Y. 10016, for their conservation film manual; also Division of Conservation Education, New York State Conservation Department, State Campus, Albany, New York.*

X. **Conservation Library** — Help the schools or the general public library establish a good conservation reference library. Refer to THE NEW YORK STATE CONSERVATIONIST reprint, "A Conservation Library." Provide a special reference file of current material for teachers and students.

XI. **This is Our Town**—How is your town introduced? Does the village sign introduce a garbage dump or junk-car establishment? Spruce trees, Scotch pine and multiflora rose may help relieve the eye-sore. Provide a corridor of beauty.

XII. **Alert for Action**—(a) Appoint a member to evaluate the national, state and local legislation in relation to conservation and keep members and local citizenry alerted to assure intelligent voting.

(b) Inform members of Wildlife Week and Arbor Day.

Create a conservation column in the local paper.

Subscribe to *The Conservation News,* National Wildlife Federation, 1412 16th Street N.W., Washington, D. C. 20006, and to THE NEW YORK STATE CONSERVATIONIST, Conservation Department, Albany.

XIII. **Natural Areas for Schools** — Many new schools are going up on treeless plains. Can plans include the preservation of a wood lot, pond or stream adjacent to the school? Plan outdoor laboratories for all grade levels. The National Audubon Society, 1130 Fifth Avenue, new York, New York 10028, has several publications to help you plan this. Read: "Conservation—In the People's Hands," American Association of School Administrators, 1201 16th Street, N.W., Washington, D. C., 20036, $6.

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*Or from comparable colleges or offices in your own state.—ED.

(*Continued from page* 31)

low for a virus to reproduce itself. Success with this method has been recorded for the disease caused by Y virus in potato, among others.

While we now know that many virus diseases of plants can be cured, we know but few details about failure to cure others. Investigators have never announced their failures as fully as they have their successes. In many cases they have merely gone on working, trying to devise new methods in the hope that they would eventually succeed.

## Projects for the Future

We need additional methods or new combinations of the old ones, to use against viral diseases not yet shown to be curable. What can be done to improve present procedures? Can ways be found to make host plants more tolerant of heat treatments without at the same time making the viruses in them equally tolerant? Are there methods other than defoliation, treatments by heat or cold, isolation and propagation of uninfected tissues or chemotherapy, by which to extend our power to cure virus diseases?

The mutual exchange of crop plants, fruit trees, and ornamentals between nations will be safer when we can treat scions for grafting and cuttings for rooting in such ways as to destroy any viruses lurking in their tissues—which otherwise would tend to be carried with their hosts to distant parts of the world. And the plants we grow for our own use and pleasure will be healthier, handsomer and more productive.

The substantial progress made in the past suggests that new methods of cure *will* be discovered. Scientists working with no precedents to guide them from 1900 to 1950 reported about fifteen cures of virus diseases in vegetatively propagated plants. The next ten years raised this number to about seventy-five. In 1966 it passed the hundred mark. ◆

# CAN EXTRA ENERGY FROM SUN BE USED BY CROP PLANTS?

*More carbon dioxide is needed in the atmosphere if photosynthesis and growth are to be increased*

## Photosynthesis

Green plants carry on the process of photosynthesis by using carbon dioxide from the air and water from their own cells, drawn in by the roots. With energy from light, primarily from the sun, the simple sugar, glucose, is made. From this, all other organic materials in the plant are constructed. The process is the basis of plant growth.

Therefore, if light is insufficient or inadequately used, or if the immediate supply of carbon dioxide runs out, glucose cannot be made and plant growth will not ensue. The great question being asked by agriculturists today is:

*Can we break this crop barrier?*

Reprinted from *The Furrow,* John Deere Company, Moline, Illinois, July-August 1966

WHAT stops crops? It may be that we are running head-on into the toughest barrier to increased crop yields. Many farmers have bumped against it already. Even now we're starting a flanking movement around it, but sooner or later you'll come solidly to grips with speed of photosynthesis. This may be the stop that sets the final limit on crop production, but if it can be broken, then literally not even the sky's the limit.

When compared with the components of photosynthesis, even nitrogen becomes a minor element or a kind of sideshow. The main feature is carbon dioxide gas from the air, acting together with water plus energy from the sun to form simple sugar. That's the essence of photosynthesis. Plants are important only because they are the stage for this, the greatest show on earth.

Light may be the easier problem to solve as we try to speed up photosynthesis. Working together, farmers and scientists are developing techniques which could insure that light won't set the limits under high yield. We are now narrowing rows to utilize more light per acre. Breeders are reshaping plants so they can better trap and use more sunshine. But looming ahead is carbon dioxide.

### Fertilize the Air?

Dry matter of any plant or plant product is made mostly of carbon from the air. The atmosphere is less than 1 percent carbon dioxide. On a sunny day, plants well supplied with water and fertilizer can't always find as much carbon dioxide as they can use. This is air, so to fertilize your farm in the conventional way would be like trying to fertilize the world. Can we solve this or will carbon dioxide be the final unbending barrier to higher crop yields?

The carbon-dioxide barrier may never be broken, at least not in the way we've solved older limiting factors such as soil fertility. But it may be pushed around.

For one thing, the world is now apparently busily fertilizing itself with carbon dioxide ($CO^2$). Every gallon of fuel you burn releases this gas back to the atmosphere and a lot of the world's supply of

$CO_2$ is still trapped in petroleum and coal reserves. Recently a British scientist at the world's oldest experiment station, Rothamsted, estimated that enough $CO_2$ will be released, by the century's end, to increase crop yield by 10 to 20 per cent. Some scientists see this as more of a threat than a blessing. The increase in $CO_2$ has a blanketing effect on the earth, cutting down radiation from earth outward. Hence the air is reportedly getting warmer. By the time the 20th century ends, one expert predicts, our climate will be an uncomfortable 7 degrees warmer.

## Doubled Yield

Where scientists have found a way to fertilize with $CO_2$, results have sometimes been spectacular. In greenhouse production of vegetables and flowers, $CO_2$ fertilization is now widely practiced. By enriching the trapped atmosphere with 4 to 5 times normal levels of $CO_2$ "glassland farmers" have sometimes doubled production. S. S. Wittwer, of Michigan State University, points to other important benefits: Plants, flowers, and fruits are bigger, better quality, quicker maturing, and healthier. Sugar and vitamin content are higher in $CO_2$-fertilized plants.

Scientists haven't yet suggested a practical way to fertilize outdoor plants with $CO_2$. They do, however, point to some practices or conditions which may favor high $CO_2$ for field crops. Corn is one crop that has been studied with interest, partly because its $CO_2$ needs are tremendous. Next to sugar cane, corn is perhaps the busiest energy factory of all. For instance, 100 bushels of corn require an intake of about 20,000 pounds of $CO_2$. When it's growing fastest, an acre of corn may take in as much as 800 pounds of the gas per day, and air around such hard-working corn is hard-put to supply this much.

## Bountiful Wind

Part of the answer is turbulent air—which keeps carrying a fresh supply of $CO_2$ to leaves. If all plants are the same height, wind tends to pass smoothly over a field without really bringing a new source of $CO_2$ into contact with leaf surfaces. Scientists speculate that as $CO_2$ becomes limiting (estimated at 150 bushels per acre in the case of corn) it may pay to create roughness, hence turbulence in the field, by planting hybrids of differing heights or perhaps seeding in rows at right angles to prevailing wind.

One expert on photosynthesis is Ed Lemon, USDA scientist at Cornell University, who believes that $CO_2$ deficiency can perhaps best be solved by plant breeders. He points to the generally open-leaf structure of a corn plant, an ideal arrangement for trapping $CO_2$. Says Lemon, "I think we can enhance the natural geometry of plants and thereby capture more carbon dioxide." But Lemon, who admits to the vital need for $CO_2$, has now turned his research guns on light.

## Flickering Sunlight

"Carbon dioxide is penny ante compared with light," says Lemon. He points out that $CO_2$ level is fairly constant and predictable, but not light. "If a cloud rolls over a cornfield, growth rate goes down." He is studying such taken-for-granted plant traits as leaf flutter which creates a flickering light. "We have evidence that this is desirable," says Lemon. "Light is used more efficiently in bursts."

On the other hand, in the sun-drenched Southwest, scientists worry more about $CO_2$ than light. Dr. J. D. Hesketh of the University of Arizona points out that as light intensity increases, $CO_2$ becomes more limiting in plant growth. Urging more research on the row-crop role of $CO_2$, he claims that its potential is far greater in field crops than in greenhouses because "light is less limiting in the field."

Photosynthesis is something you'll be hearing a lot more about. It's crucial because it brings together the two major raw materials you deal with—sunlight and carbon dioxide. To fully break the barrier of photosynthesis, you'll have to find a way to use more sunlight and supply more $CO_2$. It could be quite a challenge but stakes are high and not even the sky's the limit. ✦

# GARDENER'S MISCELLANY

**Brief Notes from 1966 Publications**

### Roses Grown by Boys and Girls

Youngsters throughout New York State are learning to be rose-growers at an early age, Ernest Schaufler reports in *American Rose Magazine* for November 1966. Through the 4H organization of the U. S. Department of Agriculture, planned programs in ornamental horticulture have been undertaken. Members of the American Rose Society have cooperated, also the rose-growing firm of Jackson & Perkins in Newark, New York, and the Department of Floriculture and Ornamental Horticulture at Cornell University. An educational session in the growing of roses precedes the distribution of plants. Through this program, 25,000 roses have been planted in New York State in six years. Many of the boys and girls are now exhibiting their flowers at county fairs.

### Sugar Maple Decline

Early coloration and leaf fall and dying back of branches characterize a decline in sugar maples that has lately become noticeable. Among the possible causes are unsuitable or drastically disturbed habitats (as along roadsides), an exceedingly shallow root system, and sensitivity to drought through both roots and leaf cells. A change in the weather, after recent dry spells in eastern North America, may reverse the trend, according to Arthur H. Westing in *Economic Botany*, April-June 1966.

### Correction on Pest Control

Contrary to suggestions in the table entitled "Familiar Plants — Their Common Pests and Diseases and How to Control Them" in the HANDBOOK ON GARDEN PESTS (*Plants & Gardens*, Spring 1966), it is recommended *not* to use malathion on ferns or on jade-plants and other crassulas. This instruction, in fact, appears on malathion bottles. The incorrect information was inadvertently given in the table.

### Water Culture

The culture of plants in water instead of soil, known as hydroponics, requires extremely precise measurements of the nutrient solution and special attention to numerous aspects of growth and care. Details are given in terms for the amateur to understand in *The Garden Journal* of The New York Botanical Garden for November-December 1966. The author is Richard M. Klein.

### Seeds in Water

Tap water with enough Lavoris to color it deep pink has made a satisfactory medium for germinating amaryllis seeds, Dr. Philip G. Corliss of San Diego, California, reports in *Plant Life*, The Amaryllis Year Book 1966.

### Soil for Roses

Analyze rose-garden soil every year or two and strive to maintain the correct acidity (approximately pH 6.5), is the advice of Harold H. Allen, writing in *American Rose Magazine* for May 1966. He explains various factors that tend to make soil either too acid or too alkaline for roses and warns that it takes a year to correct a bad condition.

### Leaf Strength

Leaves that are susceptible to damage by wind and hail may in time be strengthened so as to resist these forces, if recent experiments at the Connecticut Agricultural Experiment Station are carried to their con-

templated conclusion. In studies on tobacco leaves, Dr. H. Paul Rasmussen found that it is calcium pectate that holds leaf cells together and thereby makes leaves stronger when it is in good supply.

Subsequently, he succeeded in strengthening leaves on living plants by making extra calcium available to them. The story of his experiments is told in *Frontiers of Plant Science,* published by the Experiment Station in New Haven, Spring, 1966.

**Fluorescent Lights**

Under the title of "Packaged Sunshine," Richard M. Klein of The New York Botanical Garden presents comprehensive instructions for the growing of plants under fluorescent lights in *The Garden Journal* for July-August and September-October 1966.

**Filtered Air**

If greenhouse air is filtered, plants will be less damaged, especially in areas where such pollutants as automobile exhaust and factory wastes burden the atmosphere. A carbon filter in the air-conditioning system is advised by Dr. Howard E. Heggestad, Plant Pathologist of the U. S. Department of Agriculture's Agricultural Research Service.

**Miniature Rose Magazine**

Miniature rose growers are producing a miniature magazine, the first number of which appeared in the summer of 1966. Peggie Schulz is editor-in-chief, Elvin McDonald the publisher. Copies may be obtained with a $4 annual membership in the Miniature Rose Society of America, P.O. Box 1481, Kansas City, Missouri 64141.

**Hotels for Plants**

Vacationers in Munich, Germany, have the services of a plant hotel where their house plants can be given expert care while they are away. The scheme is described in *Florist and Nursery Exchange* for April 30, 1966. A similar service in Buxton, England, is mentioned in the *Bulletin* of the American Dahlia Society for last February.

**Carbonated Water**

When chrysanthemums at Kansas State University were misted with carbonated water, it is reported in the *Bulletin* of the National Chrysanthemum Society, they bloomed two weeks ahead of schedule. Lettuce that was similarly treated produced three times normal growth.

# CHESTNUT PROBLEM

"LONG-RANGE program needed for the American chestnut." This is the title of a major article by Paul M. Tilden in the *National Parks Magazine* for March 1966. The story of the chestnut (*Castanea dentata*) is carried from some of the earliest observations of the tree in North America, through the discovery of the deadly Asiatic fungus, *Endothia parasitica,* in New York's famous Bronx Zoo in 1904, to some of the recent efforts at breeding a blight-resistant strain.

These efforts, the author maintains, have not been well enough supported. They have, in fact, been rather ineffectual. What is needed, he indicates, is a "long-term, well-financed, well-staffed restoration program"—one that will be kept active through future generations of men and chestnuts, or even into future centuries.

"Surely," he concludes, "a people able to afford a man on the moon might well deal more generously with one of the challenging forestry problems of our time."

# BOOKS WORTH READING

*Selections from 1966 publications*

## Gardening in General

**Trees for American Gardens.** Donald Wyman. 501 pages, illustrated with numerous photographs by the author and from Arnold Arboretum files. Revised and enlarged edition. Macmillan, New York. $10.95.

New information about trees is in large part derived from the long-kept records of the Arnold Arboretum.

**Sunset Western Garden Book.** Sunset editors. 448 pages (8½ x 11), more than 400 illustrations, 75 charts, 12 maps. Lane Magazine and Book Co., Menlo Park, Calif. $5.95.

The gardener in Arizona, California, Idaho, Nevada, Oregon, Utah and Washington will scarcely need to look elsewhere for horticultural guidance, for this book seems to answer all everyday needs.

**Reader's Digest Complete Book of the Garden.** Thomas H. Everett, general editor and technical adviser. 896 pages, illustrated with wash drawings in color. The Reader's Digest Association, Pleasantville, New York. $9.95.

**Garden Guide.** Ludwig Koch-Isenburg. 250 pages, illustrated with photographs, some in color, and drawiugs. Translated from the German by H. L. Edlin. Viking Press, New York. $5.95.

This is no conventional, routine garden book. It deals essentially with plants as ornaments for house and grounds. Among the ideas which embellish the text are the use of trees of unusual form, the planting of stone stairways, planting a dry wall, the use of moss on walls, garden urns, etc.

**The Complete Book of Gardening under Lights.** Elvin McDonald. 215 pages, illustrated. Doubleday, Garden City, N. Y. $4.95.

A practical book, written out of the author's own experience. Chapters cover various types of lighting and how to apply them, cultural directions, plant propagation, pest control, and special plants.

**The Picture Book of Annuals.** Arno and Irene Nehrling. 288 pages, abundantly illustrated, 8 plates in color. Hearthside Press, New York. $6.95.

**How to Control Plant Diseases in Home and Garden.** Malcom C. Shurtleff. 649 pages, illustrated. Second edition. Iowa State University Press, Ames, Iowa. $8.50.

A comprehensive guide for the home gardener that gives effective control measures for more than 5,200 diseases.

**The Flowering Greenhouse Day by Day.** Elvin McDonald. 158 pages, illustrated with drawings by Kathleen Bourke and with photographs. D. Van Nostrand Company, Princeton, N. J. $6.95.

With chores assigned for every weekend of the entire year, on a month-by-month basis, this book has special value for the greenhouse gardener who must be away from his plants on business days.

**1001 Western Garden Questions Answered.** Norvell Gillespie. 239 pages. D. Van Nostrand Co., Princeton, N. J. $6.95.

Garden planning, trees, shrubs, flowers, fruits and vegetables, soil and garden upkeep are some of the topics treated. A glossary gives the botanical names of all the plants mentioned by common name.

**Moisture Gardening.** Alan Bloom. 125 pages, illustrated with photographs. Charles T. Branford Co., Newton Centre, Mass. $7.95.

**The Cool Greenhouse All the Year Round.** L. N. Flawn and V. L. Flawn. 163 pages, 42 photographs, 28 drawings (diagrams). John Gifford Ltd., London W.C. 2. $4.50.

**Handbook for Greenhouse Gardeners.** Elvin McDonald, editor. 92 pages, illustrated with drawings by Kathleen Bourke, paper-covered. Lord & Burnham, Irvington-on-Hudson, New York, 10533. $2.95.

A highly practical little book, especially for the beginner.

## Special Plants

**Dwarf Conifers.** A Complete Guide. H. J. Welch. 334 pages, color frontispiece, 20 identification plates and 285 halftone illustrations. Charles T. Branford Co., Newton Centre, Mass. $13.50.

This major work by an English nurseryman can be a valuable aid to identification and culture. It extends coverage of the subject in the Brooklyn Botanic Garden's *Handbook on Dwarf Conifers,* edited by Helene Bergman.

**African Violet and Gesneriad Questions Answered by 20 Experts.** Helen Van Pelt Wilson, editor. 272 pages, illustrated with drawings by Judith Hirtle. D. Van Nostrand Co., Princeton, N. J. $6.95.

**Growing Orchids for Pleasure.** Jeanne Garrard. 302 pages, illustrated, 4 pages in color. Thomas Yoseloff, Ltd., London; A. S. Barnes and Company, New York. $7.50.

An informally written book with an abundance of illustrations. "How to Interest Children in Orchids" is one important chapter. The author herself grew up growing orchids.

**All About Rock Gardens and Plants.** Walter A. Kolaga. 385 pages, illustrated with photographs and drawings, Doubleday, Garden City, N. Y. $4.95.

The title "All About . . ." is always a dangerous one to use, but this book comes close to fulfilling the promise. The appendix tabulates the many kinds of plants for special uses and situations.

**Flowers in the Winter Garden.** M. M. Graff. 203 pages, 16 illustrations in halftone and color. Doubleday, Garden city, N. Y. $4.50.

Bulbs and shrubs are the principal producers of bloom between November and March, and the author writes of many kinds.

**The Strawberry—History, Breeding and Physiology.** George M. Darrow. 447 pages, illustrated, 20 plates in color. Holt, Rinehart & Winston, New York. $15.

The definitive work on the subject.

**Fuchsias.** Stanley J. Wilson. 293 pages, 8 color plates, 24 halftone photographs. St. Martin's Press. New York. $10.00.

"A complete guide to their propagation and cultivation for house and garden."

**The Rockwells' Complete Book of Roses.** F. F. Rockwell and Esther C. Grayson. 332 pages, illustrated with 146 photographs, 44 in color, and 30 line drawings. Revised and updated edition. Doubleday, Garden City, N. Y. $5.95.

**Daffodils, Tulips and Other Hardy Bulbs.** M. J. Jefferson-Brown. 160 pages, 16 illustrations in color and 17 black-and-white photographs. John Gifford Ltd., London, W.C. 2. $4.95.

**Primroses and Spring.** Doretta Klaber. 125 pages, illustrated with drawings by the author, M. Barrows & Company, New York. $4.50.

**Proteas for Pleasure.** Sima Eliovson. 228 pages, (7 x 9½), illustrated with photographs, 48 in halftone, 34 in full color. Howard Timmins, Cape Town. $8.50.

How to grow and identify these exquisite native flowers of South Africa.

**The Aloes of Tropical Africa and Madagascar.** G. W. Reynolds. 537 pages (7½ x 10½), illustrated with many halftones and 104 color plates. The Trustees, The Aloes Book Fund, Mbabane, Swaziland. $29.80 (for special subscribers' edition).

A detailed botanical presentation with interesting supplementary information.

**The Complete Vegetable Grower.** W. E. Shewell-Cooper. 288 pages, illustrated mainly with drawings. Faber and Faber, Ltd., London. $4.51.

All that the gardener in England needs to know about growing 75 or more different home food and flavoring crops.

## Year Books

**American Rose Annual.** O. Keister Evans, Jr., editor. 247 pages, 12 pages in full color, American Rose Society, Columbus, Ohio. $5.00. Free with membership in American Rose Society.

**The Rose Annual 1966.** Leonard Hollis, honorary editor. 239 pages. 10 halftones, 15 color plates. The Royal National Rose Society, St. Albans, Hertfordshire, England. $1.83.

**The American Camellia Yearbook 1967.** Edited by Joseph H. Pyron. 314 pages, illustrated, 8 plates in color. American Camellia Society, Tifton, Ga. $6.00.

**The Gladiolus 1966.** Mrs. P. C. Vasaturo, editor. 256 pages, illustrated. New England Gladiolus Society, Boston. $3.00.

## Herbs

**Herbs for Every Garden.** Gertrude S. Foster. 255 pages, illustrated with drawings by Elizabeth B. Hull and photographs by Philip W. Foster. E. P. Dutton & Company, New York. $4.95.

Intriguing recipes containing herbs accompany the treatment of many of the species in this book.

**Early American Herb Recipes.** Alice Cooke Brown. 152 pages (8½ x 11), illustrated with photographs and sketches. Charles E. Tuttle Co., Rutland, Vt. $10.00.

**Herbal Handbook for Everyone.** Juliette de Bairacli Levy, 178 pages, Charles T. Branford Co., Newton Centre, Mass. $6.95.

## Wild Flowers

**Wild Flowers of the United States.** Volume I (in two parts), The Northeastern States. Harold William Rickett. 559 pages, 9½ by 12½ inches, illustrated with approximately 1,200 color photographs and with 350 drawings by Rachel Speiser. The McGraw-Hill Book Company New York. $39.50.

The first of five monumental volumes, this large pair of books treats wild flowers of the northeastern quarter of the country. The descriptions are interspersed with entertaining comments on the plants. An illustrated glossary, showing plant parts in detail, gives helpful guidance to botanical terms.

## Landscaping

**A History of Garden Design,** revised edition. Derek Clifford. 252 pages, 82 halftone illustrations. Frederick A. Praeger, New York. $16.

A highly readable account of the development of the art of landscaping in classical times, in medieval times, and in later centuries in Europe, in the Orient and in America. An entertaining chapter that precedes the long appendices is entitled "The Triumph of the Wild Improvers."

**Designing a Garden Today.** J. E. Grant White. 184 pages, illustrated with photographs by the author. Abelard-Schuman, New York. $6.50.

Gardens that the author has himself designed, mainly in England, form the basis of this book. One chapter deals with problems a designer encounters—legal and psychological among them.

## Japanese Gardens and Bonsai

**Magic of Trees and Stones**—Secrets of Japanese Gardening. K. Saito and S. Wada, translated by Richard L. Gage. 282 pages (8¼ by 12), illustrated with photos by Akira Ohira and with drawings. Japan Publications Trading Co., Rutland, Vt. $12.50.

**Japanese Garden and Floral Art.** Mrs. Paul Kincaid. 189 pages, illustrated with 99 drawings and photographs. Hearthside Press, New York. $6.95.

Pictures include a number of the classical gardens in Japan, and Brooklyn Botanic Garden's famous Hill and Pond garden.

**The ABC of Japanese Gardening.** Isamu Kashikie, translated by John Nathan. 64 pages, paper covered, illustrated with drawings. Japan Publications Trading Co., Rutland, Vt. $1.00.

**Bonsai; Indoors and Out.** Jerald P. Stowell. 134 pages, illustrated with photographs and drawings. D. Van Nostrand Co., Princeton, N.J. $4.95.

A small book which includes bonsai plants from the wild, by an American practitioner of the art.

**Photos of Now Famous Bonsai.** Edited by Kenji Murata. 134 pages, photographs of 52 bonsai, two in color; text in Japanese, Japan Publications Trading Co., Rutland, Vt. and Tokyo, Japan. $7.70.

## Flower Arrangement

**Flower Arrangements to Copy.** Tat Shinno. 246 pages, illustrated by the author, partly in color. Doubleday, Garden City, N. Y. $7.95.

Although a list of all plant materials used in some hundred or more arrangements is included in the book, the author's emphasis is on the *feeling* elicited by the arrangement, whether the plants used are identical or only similar.

**New Decorations with Pods, Cones and Leaves.** Eleanor Van Rensselaer. 199 pages, 64 illustrations and 4 color plates from photographs by Doug Morris. D. Van Nostrand Co., Princeton, N.J. $6.95. How to make 80 entirely new designs

with nature's ornaments—pods, cones, leaves, shells, and many more.

**The Driftwood Book.** Mary E. Thompson. 248 pages, illustrated with 160 photographs by Leonid Skvirsky. Second edition. D. Van Nostrand Co., Princeton, N.J. $5.95.

**New Trends in Flower Arrangement.** Rae L. Goldson. 122 pages, 99 half-tones. Hearthside Press, New York. $4.95.

**Resin and Glass Artcraft for Flower Arrangers and Craftsmen.** Lura Smith. 115 pages, illustrated with photographs by Doug Morris, 3 pages in color. M. Barrows & Co., New York. $4.95.

**Wedding Flowers, Decorations, Etiquette.** Virginia Clark. 160 pages, illustrated with drawings and photographs, nine in color. Revised edition. Hearthside Press, New York. $6.95.

## Emphasis on Pictures

**Patterns of Life.** The Unseen World of Plants. William M. Harlow. Foreword by Paul B. Sears. 128 pages, illustrated. Harper & Row, New York. $6.95.

Wood grain, seed capsules, flower patterns, seedlings, cones, pollen, leaf veins—these are some of the unexpected beauties of the plant world that make up the more than 80 pictures in this book. One of them is shown on the cover of this issue of P&G.

**The Glory of the Tree.** B. K. Boom and H. Kleijn. 128 pages, (8½ x 11), 194 color illustrations of trees of the world by G. D. Swanenburg de Veye, also line drawings of tree details. Doubleday, Garden City, N.Y. $12.95.

The photographs are both magnificent and varied—some of full-sized trees against a scenic background; others of bark, needles, leaves, cones, flowers or fruit. The text is written for the layman.

**The World of Flowers.** Herbert Reisigl, editor. 240 pages, illustrated largely in color. Viking Press, New York. $12.50.

Spectacular plant and flower photographs against backgrounds of dramatic scenery.

**Flowers of the Mediterranean.** Oleg Polunin and Anthony Huxley. 257 pages, 311 flowers in full color from photographs by the authors; illustrated also with line drawings by Barbara Everard. Chatto and Windus, London, England. 2/2/- ($9.75).

**Annual Flowers in Color.** Paul F. Frese, 144 pages), 8½ x 11), illustrated with photographs in halftone and color. Grosset & Dunlap, New York. $4.95.

How to plan, plant and care for a garden with annuals.

**The Pictorial Encyclopedia of Plants and Flowers.** F. A. Novak, edited by J. G. Barton. American consultant, H. W. Rickett. 589 pages of illustrations, some in color. Paul Hamlyn, London; Crown Publishers, New York. $10.

Microscopic photographs of bacteria and algae open this book of more than a thousand pictures; ripened ears of corn conclude it. In between, all the major groups of plants are illustrated.

**Flower and Garden Photography.** D. X. Fenten. 128 pages, illustrated in halftone and color. Amphoto, New York; Chilton Books, Philadelphia. $4.95.

Advice is given on composition, close-up views, outdoor scenes and indoor subjects including exhibitions, along with different cameras and their equipment.

## For Reading as Well as Reference

**Our Natural World.** Hal Borland, editor. 349 pages, illustrated with drawings by Rachel S. Horne. Doubleday, Garden City, N.Y. $9.95.

A large and varied collection of delightful essays about the land and wildlife of America from the time of discovery to the present day. Noteworthy among the 88 authors are Rachel Carson, Joseph Wood Krutch, Betty Flanders Thomson, John Kieran, Robert Cushman Murphy, Edwin Way Teale and Roger Tory Peterson.

**Plant Drugs that Changed the World.** Norman Taylor. 275 pages, illustrated with drawings by Margaret Cosgrove. Dodd, Mead & Co., New York. $5.00.

Stories are told here of many kinds of drugs, used through the ages and around the world, from the willow leaves recommended by Dioscorides for gout, and the Chinese species of *Ephedra* mentioned by the Emperor Shen Nung as a remedy for numerous diseases, to the present-day use of LSD, a derivative of the fungus ergot.

**Where the Sea Breaks its Back.** The Epic Story of a Pioneer Naturalist and the Discovery of Alaska. Corey Ford. 206 pages, illustrated with drawings by Lois Darling. Bibliography. Little Brown & Co., Boston, Mass. $5.95.

**John Torrey.** A Story of North American Botany. Andrew Denny Rodgers III.

352 pages, portrait frontispiece. Hafner Publishing Co., New York. $7.50.

The personal and scientific life of the man who first classified the plants then known in North America is told in detail.

**Science and Survival.** Barry Commoner. 150 pages, Viking Press, New York. $4.50.

**Daffodils are Dangerous.** Hubert Creekmore. 258 pages, illustrated with drawings by Helen Spence. Walker and Company, New York, $4.95.

A compendium of warnings about the poisonous properties of many commonly cultivated plants.

**Origins of American Conservation.** Edited for the Natural Resources Council of America by Henry Clepper. 193 pages. The Ronald Press Company, New York. $4.50.

**Guidelines to Conservation Education Action.** Prepared by Izaak Walton League of America, Conservation Education Association and National Audubon Society, 1130 Fifth Ave., New York, N. Y. 10028. $2.50 paper-bound; $5.00 in hardback.

## Especially for Children

**Adventure with Flowers.** Elizabeth T. Billington. 60 pages, illustrated with colored wash drawings by Arnold Dobrin. Frederick Warne & Co., New York. $2.95.

**A Trip to the Pond**—An Adventure in Nature. Melita Hofmann. 63 pages plus end-paper chart, illustrated in color by the author. Doubleday, Garden City, N. Y. $3.75.

## Technical Works

**Botanical Latin.** William T. Stearn. 566 pages, 41 plates of drawings. Hafner Publishing Co., New York. $16.75.

**Microbiology and Soil Fertility.** C. M. Gilmour and O. N. Allen, editors. 164 pages, illustrated, Oregon State University Press, Corvallis, Ore. $4.50.

**Spores:** Their Dormancy and Germination. Alfred S. Sussman and Harlyn O. Halvorson. 354 pages, illustrated, Harper & Row, New York. $14.00.

**Arcadian Technical Manual for Christmas Tree Farmers.** Lester C. Bell and Donald P. White, edited by Harvey J. Stangel. 128 pages, paper bound, extensively illustrated. Allied Chemical Corporation, 40 Rector St., New York, N.Y. 10006. $2.00.

## Reprints of Important Books

**Liberty Hyde Bailey.** A Story of American Plant Sciences. Andrew Denny Rodgers III. 506 pages, 7 illustrations. Hafner Publishing Co., New York. $10.00.

**Life of Mendel.** Hugo Iltis. Translated from the German by Eden and Cedar Paul. 336 pages, 10 illustrations and 12 plates. Hafner, New York. $5.75.

**Plant Sociology.** The Study of Plant Communities. J. Braun-Blanquet, translated, revised and edited by George D. Fuller and Henry S. Conard. 439 pages, illustrated. Hafner, New York. $8.00.

**Taxonomic Terminology of the Higher Plants.** H. I. Featherly. 166 pages. Hafner Publishing Co., New York. $4.25.

A glossary of words used by botanists in describing and naming plants.

**Flora of the Prairies and Plains of Central North America.** Per Axel Rydberg. 969 pages, illustrated. Hafner Publishing Co., New York. $12.00.

**Flora of Bermuda.** Nathaniel Lord Britton. 484 pages, illustrated. Hafner Publishing Co., New York $12.00.

**The Wild Flowers of California.** Mary Elizabeth Parsons, illustrated with drawings by Margaret Warriner Bucks. Paper bound. A new table of changes in nomenclature prepared by Roxana S. Ferris. Dover Publications, New York. $2.25.

**Flora of the Hawaiian Islands.** W. F. Hillebrand. 673 pages, frontispiece and maps of the Hawaiian Islands. Hafner Publishing Co., New York. $20.00.

**In Gardens of Hawaii.** Marie C. Neal. 924 pages. 317 illustrations (drawings and half-tones). Bishop Museum Press, Honolulu, Hawaii. $15.00.

**How We Got Our Flowers** (original title: The Coming of the Flowers). A. W. Anderson. 283 pages, illustrated, paper bound, Dover Publications, New York. $1.75.

**The Living Cycads.** Charles Joseph Chamberlain. 172 pages, illustrated with photographs and drawings. Hafner Publishing Co., New York. $4.00.

**Gymnosperms.** Structure and Evolution. Charles Joseph Chamberlain. 484 pages, 397 illustrations. Paper bound. Dover Publications, New York. $2.75.

**A Mycological English-Latin Glossary.**

Edith K. Cash. 152 pages, Mycological Memoir No. 1. Published for The New York Botanical Garden in collaboration with the Mycological Society of America. Hafner Publishing Co., New York. $8.50.

# LEAFLETS, BULLETINS AND BOOKLETS AVAILABLE

**Guide for Buying Roses 1967.** American Rose Society, 4048 Roselea Place, Columbus, Ohio 43214. Free, with stamped, addressed envelope.

**Growing Flowering Perennials** (USDA Home and Garden Bulletin No. 114). Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

**Trees for Shade and Beauty,** Their Selection and Care (USDA Home and Garden Bulletin No. 117). Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. 10 cents.

**Tune In to Nature.** A Pictorial Essay, illustrated partly in color. Ruth H. Smiley. A pleasant introduction to the varied life of the outdoors throughout the year. Mrs. Keith Smiley, Mohonk Lake, New Paltz, N. Y. 12561. 75 cents (50 to 60 cents in bulk).

**For a Beautiful America Guard Against Plant Pests.** (U.S.D.A. publication PA-725). Information Division, Agricultural Research Service, U. S. Department of Agriculture, Hyattsville, Md. 20782. Free.

**A Guide to Safe Pest Control Around the House.** 41 pages, 8½ x 11. Cornell Miscellaneous Bulletin 74, Ithaca, New York 14850. 75 cents.

**Insect and Mite Pests of Trees and Shrubs.** R. B. Neiswander. 54 pages, 8½ x 11, illustrated in color. Research Bulletin 983, Ohio Agricultural and Research Center, Wooster, Ohio. $1.00.

**A Catalog of New and Noteworthy Fruits, 1966-67.** New York State Fruit Testing Cooperative Association, Geneva, N. Y. 14456. Free.

**A Citizen Guide to Action for Clean Water.** Izaak Walton League, 1326 Waukegan Road, Glenview, Ill. 60025. Free.

**Elm Bulletin** (quarterly). Published with the aim of saving the American elm from extinction. Elms Unlimited, 60 West Prospect St., Waldwick, N. J. Free.

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